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Siphonic Spillways

TESTS made on the siphonic spillway at the forebay of Ocoee power station 2 are described on page 567 of this issue. These tests are interesting because they are among the first performed with accuracy in order to obtain the efficiency of siphons designed and built in this country. Siphons are peculiarly well fitted for installations where an automatic and quick discharge of surplus water is required, and engineers will, therefore, be interested to know the predetermined requirements and the operating results as described in Mr. Creager's article. Considering that the design of siphonic spillways is still in its infancy in this country, the efficiency obtained is gratifying. As their design is largely governed by experience and local conditions linked with theoretical speculations as to what takes place during the priming period, engineers should not indiscriminately apply the design used at the Ocoee station. In the case referred to it was almost impossible to submerge the downstream openings of the siphons by building a tailrace. One of the photographs shows that these openings are located at different elevations. Had all openings been placed at the lowest elevation additional excavation and yardage of concrete would have been required; had they all been placed at the higher elevation the average head would have been decreased. European experience has shown that siphons having easy curves at the throat, inclined downstream legs, sharp edges at both the intake and discharge, and submerged lower openings give the best operating results. This experience suggests, therefore, that it might have been possible to obtain a higher efficiency at Ocoee had the curve at the throat not been as abrupt as that designed. It would also have been possible to submerge each siphon outlet individually by forming a water pocket, which would have permitted the inclination of the downstream leg. There is no doubt, however, that the siphons as designed will serve the purpose for which they have been installed, as the designer wisely allowed a large factor of safety.

Coast Survey's Practical Work

THE average engineer noting that the U. S. Coast and Geodetic Survey has issued a publication describing "The Fourth General Adjustment of the Precise Level Net in the United States and the Resulting Standard Elevations" might be pardoned for failure to evince a wild desire to capture the volume for instant perusal. Hypsometry is hardly a term to kindle the imagination, and the imposing tabulations of bench-mark elevations could very well suggest only admiration for the painstaking typesetter and proofreader who co-operated in furthering their début. There is, therefore, need to indicate the extremely practical nature of the data published and the high standard of the work which made them possible. The net embraces more than 2000 precise level determinations that have been made in this country and across the border by Government engineering organizations, principally by the Coast Survey. The labor of co-ordinating these elevations into one system can be thoroughly appreciated only by one who has been engaged in such work. The net covers forty States, extending from coast to coast and from southern to northern boundaries. From time to time adjustment of the whole system has been necessitated by the small errors that prove that human accuracy is only relative, and by the variations, at separated points, of that fickle plane called mean sea level. A few of the most erudite of this journal's readers may be pleased to know that the current report differs from its predecessors in that the orthometric instead of the dynamic correction has been applied to the standard elevations west of the Mississippi River, and all should be interested to know that all data are given in feet as well as in meters. The book stands as a remarkably precise index of elevations of bench marks distributed over the country—a reference book of points that have been painstakingly spiked down and clearly labeled. There are few readers who will not have occasion at some time to use some of the data given, and it is well for them to appreciate that the establishment of this remarkable system has required the most painstaking work, eternal vigilance and an unusually high degree of skill.

Highway Department Bulletins

SO much chaff comes to the editorial mill from sources of highway news that the occasional kernel of useful information deserves publicity. The State highway departments of New York and Iowa publish bulletins of their respective activities, which, besides accomplishing their local purposes, make meaty reading for anyone interested in road development, due to the intelligent effort made, in each case, to place before the residents of the State a survey of the department's operations, emphasizing what is new or of unusual magnitude. Although it is too much to expect that the mistakes of the engineering administration should be accorded prominence, each of the publications has the merit of speaking with accuracy and authority on the questions more obviously within its province, in grateful contrast to the stereotyped utterances of those professional road boosters who lower the standard of highway literature while adding to its total. The New York "Highway News" first appeared in September, 1913. Two numbers have followed. Besides being typographically attractive, the bulletin shows, in the articles contributed by officials of the department, an evident desire to give the public a faithful perspective of the workings of the highway organization and of the results gained. The Iowa "Service Bulletin" goes farther, by graphically directing attention to current evils, such as weak culverts and bridges, dangerous grade crossings and right-angle turns. One number shows on its front cover the wreck of a threshing machine which crashed through a rotten wooden bridge, and under it the caption "What Chance Did Johnson Have Under This?" This treatment is calculated to capture the attention of the average road user, exactly the function of such a publication. A bulletin of this type, too, can materially aid in impressing on the public the importance of a proposed highway measure or the reason for adopting a new type of construction or a new maintenance policy. It is to be hoped that each of the excellent papers has a wide circle of readers and that other highway departments will pattern after them.

"Times" Engineering Supplement

FOR nine years the London "Times" issued a weekly engineering supplement, a four-page newspaper-size sheet reviewing engineering conditions not only in England but throughout the world. This was an unusual feature for a newspaper, especially since it was not confined to a review of industrial conditions, but, in its technical descriptions and abstracts, went far beyond the point where the interest of the layman will lead him. It is true that the character of the articles was not such as is expected of, and found in, the leading British engineering journals. Nevertheless, the treatment was far more technical than would be expected of a newspaper. Moreover, the supplement carried regularly a full column of editorial comment. When the "Times" was recently reduced in price to a penny, the weekly engineering supplement was discontinued and a monthly issue, appearing on the last Friday of every month, substituted. In the new form the supplement is a twenty-four page book, of half newspaper size, which preserves the main characteristics of its predecessor. The available space allows more thorough treatment of all departments. Special articles, news of the month, societies and institutions are the main classifications under which the articles are carried. There are regular departments devoted to new engineering books, notes on industry and invention and on certain of the engineering specialties. It would appear that the supplement is designed chiefly not for the practising engineer but for the financier and the business man concerned with works based on engineering practice. That end is served admirably. In the original form it is likely that the supplement was the means of bringing to a great many laymen news of engineering work that they would not otherwise have obtained, for the supplement was issued with the newspaper itself without extra cost. These scattering readers are now likely to be lost in large part, for under the new arrangement the supplement and the newspaper are sold separately, though the combined cost of the two is not any higher than was the price before. The "Times" did well to retain, under the price readjustment, this valuable supplement. The new shape will allow it to serve its purpose better than before, except that the timeliness permissible in a weekly journal is now impossible.

Camp Sanitation in Mexico

WHEN it was announced that General Funston had landed United States troops at Vera Cruz and was making preparations to establish camp sites in that territory there was added to the general interest in the Mexican situation a phase which is of peculiar interest to the sanitary engineer. Upon the degree of thoroughness with which a comprehensive plan of sanitation is enforced—especially in a tropical country—depends the success, or failure, of any military operation involving large bodies of men. The people of this country have not forgotten the awful harvest in human lives which camp diseases reaped during the war with Spain.

What will be the outcome in the event of an extended invasion of Mexico? This is the question which the Engineering Record addressed to the Surgeon-General of the United States Army, General Gorgas, and his reply forms the leading article in this issue. Since 1898 great strides have been made in camp sanitation and military hygiene, and it is reassuring to learn from so distinguished an authority that the army is prepared to enter any campaign in an enlightened state of hygienic competence and that the disabilities of war—if war there should be—will be limited, for the first time in the history of the New World, principally to bullet wounds. It is an old axiom among soldiers that moving troops are never sick. It is in the encampments that the most insidious foe must be fought. The sanitary campaign covers such problems as pure drinking water in the enemy's country, disposal of wastes and the prevention of infectious diseases.

These are the very problems with which sanitary engineers in cities must cope in times of peace, and it is interesting to learn how they are influenced by the exigencies of war. General Gorgas has done a real service in explaining how the army is prepared to meet any emergency. If a general call for volunteers should be issued, an understanding by prospective recruits of the fundamentals of military sanitation, as outlined in this week's article, should do much to lighten the burden of instruction at mobilization camps and have a beneficial influence in maintaining the high standard of health which General Gorgas predicts for field-service conditions.

Terminal Freight Congestion

ADVOCATES of motor trucks to alleviate street congestion at large terminals forget that the motor truck is not economical if it must spend half its time waiting at the freight house. As Mr. Hortter, car accountant of the Boston & Maine, said in addressing the Electric Vehicle Association of America on April 24, relief lies in a change of method rather than tools. Mr. Hortter's paper is abstracted on page 564. The remedy he proposes is a consolidation of trucking interests and the operation of trucks on regular schedules, the vehicles picking up and delivering freight all along their routes, doing in each trip the work otherwise done by a number of wagons independently operated.

In the discussion of the paper several laid the street congestion to failure of railroads to provide mechanical facilities at the freight houses. Their criticisms seem to be based mostly on conditions in New York City, which are unique and do not lend themselves to any easy solution. It is true that the railroads have been slow to adopt mechanical devices—for the good reason that machinery entirely adaptable to the conditions has not yet been designed. The Missouri, Kansas & Texas, for instance, has found its telpher system at St. Louis unsuited to the miscellaneous character of freight handled and has abandoned it. The hand truck has a flexibility for entering cars and corners still unattained by mechanical devices. But while the railroads have been unable to satisfy themselves as to the adaptability of machinery for package freight, they have certainly made advances—in the segregation of inbound and outbound freight in separate houses, in building lighter and better buildings, in providing broader and better paved driveways and more and better arranged team tracks and in installing pillar and gantry cranes for handling heavy or bulky pieces of freight.

An argument not so easily met by the railroads is that they themselves should do the trucking. Warehouse-to-warehouse freight handling has been put to the test and found satisfactory in Europe, and the system ought to be effective in the United States. For any trucking company the attempt to secure all the business would be fraught with financial and legal risks. Once the principle was established, however, that freight transportation meant all the way from shipper to consignee, the rate could be made to cover the whole and the railroads would equip themselves for the street service as a matter of course.

How Far Can the State Go in Price Regulation?

FOR some unknown reason far less attention than it deserves has been paid to the decision of the Supreme Court in the Kansas insurance case. This decision was quite as important as those in the leading trust cases, for if it means what Chief Justice White says it means it "points inevitably to the conclusion that the price of every article sold and the price of every service offered can be regulated by statute." This is from the dissenting opinion of the court. The prevailing opinion does not appear to warrant such a characterization, but who would have the temerity to differ from the Chief Justice of the United States Supreme Court as to the meaning or application of one of the court's decisions? The only excuse for such boldness is that six justices of the court say that their decision does not carry the meaning that Justice White has read into it.

The case (German Alliance Insurance Company vs. Superintendent of Insurance of Kansas) involved the question as to the power of the State to regulate the rates of fire insurance, and was brought following the attempt in Kansas to reduce fire-insurance rates.

The substance of the majority opinion of the court is that fire insurance by reason of its importance to the community is not a private business but one of public interest and concern; that contracts of insurance have greater public consequence than contracts between individuals, and that insurance companies are entitled to a lesser degree of liberty. The six justices who sign the opinion assert that it relates solely to the power of the State to regulate insurance and does not necessarily include any other business or the right to fix the price of commodities. There was no question as to the reasonableness or otherwise either of the insurance companies' rates or those that the State sought to enforce. The question before the court related simply to the power of the State to fix rates at which insurance companies should be allowed to do business.

The dissenting justices—White, Lamar and Van Devanter—as already indicated, do not share this view. To find Justice White on the dissenting side of the case is a distinct encouragement to believe that his interpretation of the law will prevail in the end, for it was this jurist who after repeated dissents from the court's trust law decisions finally brought it to agree with his "rule of reason." It is another rule of reason that he applies in the insurance case. If the prevailing opinion is to stand, he says, "then every business with great capital and many customers distributed throughout the country must be treated as affected by a public interest, and the price of the goods on its shelves can be fixed by law." The Chief Justice instances the publication of newspapers and periodicals as something that "profoundly affects public thought and public business," and therefore justifies State regulation, but not the fixing of the price of publications or their advertising rates.

Following the theory of the majority opinion to the bitter end the dissenters point out that if the aggregate size of each class of business is the test by which it is to be determined whether or not it is affected with a public interest—which is said to be the equivalent of public use—the same principle might be applied to the business of farming, and the price of wheat and corn, cotton and wool, beef and pork, fruit and vegetables could be fixed by law. Following the same reasoning, it is asserted that the price of labor and of everything else necessary to modern life could be regulated by statute.

Industry will hope that the prevailing opinion will not be stretched to cover every human activity and commodity of such a general character that might, by what appears to be the distortion of view in this case, be held to be "affected with a public use." Once started along this line it is difficult to see where the State would stop unless it was just on the near side of regulating the price of diamond tiaras, caviar and left-handed monkey wrenches.

An Illuminating Appraisal

VIOLATING the usual custom of the Engineering Record, of publishing only short articles, nearly five pages are given in this issue to an abstract of the Lehigh Valley appraisal report, made by William J. Wilgus. The importance of the document, however, fully warrants the space taken. Moreover, in a subsequent issue the Engineering Record expects to present still more of the report in an abstract of an appendix, not here touched upon, which might be called a specification for the appraisal of any large railroad.

Careful reading of the summary Tables 1 and 2 is recommended. Here is a railroad found to be worth $324,000,000, and of this amount only $241,000,000, or 75 per cent, is made up of "measurable items," which in the opinion of many who have not studied the matter constitute the whole value. Mr. Wilgus shows that the overhead charges, which are essential to the building of a railroad, are no less than 30.74 per cent of the measurable items—and would be 35.37 per cent with the interest figured properly. The value of the main line per mile, exclusive of equipment, is shown to be $278,898. This figure will arouse the ire of those who think all capitalization above $30,000 per mile is pure water; it is less, however, than the New York Public Service Commission figured that the Buffalo, Rochester & Eastern, to which it some years ago denied a certificate of necessity, would cost. In other words, a governmental regulatory body—disinterested beyond question—has made an estimate, for a proposed railroad of the same class, in similar territory, in excess of the unit cost Mr. Wilgus has found.

The discussion of overhead charges, and especially of general expenditures, is, in the opinion of the Engineering Record, the most masterly discussion of this phase of valuation that has appeared since the general subject has come before the public. As Mr. Wilgus states, common practice has been to fix—and he might have said guess at—percentages for such items as law expenses, stationery and printing, and the like. Mr. Wilgus, however, has analyzed them on the basis of present expenditures and additional costs during the construction period.

One of the most valuable parts of the report, from the broad viewpoint, is the analysis of interest during the construction period. Arguments for allowing "interest on the interest" have been heard in technical societies, but the hearers undoubtedly have looked upon such discussions as feats of mental gymnastics, without any great significance in dollars and cents. Therefore the average engineer is not prepared for Mr. Wilgus' figures. To the astonishing sum of $35,000,000 for interest during construction, as calculated by the usual method, he adds the amazing figure of $18,000,000 to cover the interest when the financing is handled as it has to be in real life—and he establishes his case beyond question. No amount of logic, unsupported by examples, has ever made such an impression as to this item of expense as will doubtless follow the comprehension by engineers, financiers and members of utility commissions of these figures made by Mr. Wilgus. Evidently "interest on the interest" is not to be dismissed as a mere bagatelle.

As an analysis of the value of the Lehigh Valley Railroad, as a defense against unjust charges of overcapitalization and inflation of values, as a specification for the handling of any railroad appraisal and as a technical study of the so-called intangible items, the Wilgus report is a masterpiece. With full confidence, therefore, the Engineering Record commends it to the careful study of its readers.

Patent Office Procedure

ELSEWHERE in this issue is a statement of the conditions, revealed by an investigation by one of the Engineering Record's representatives, under which the patent on the high-pressure boiling (or autoclave) cement test was granted. Although the German patent of Michaelis on a high-pressure steam test ("kochprobe" is the term used in the German patent) was on file in the Patent Office, as were also card-index references to descriptions of the test in books in the library of the Office, these anticipations were not cited against the claims made by Mr. Force. In other words, though the rules provide that a patent shall not be granted if the idea has been described or in use two years before the date of application, no search of foreign or domestic technical literature was made to determine whether there had been any previous description. Furthermore, it hardly seems possible that the search of foreign patents could have been thorough, in view of the failure to find the Michaelis patent.

This condition calls for severe condemnation. The report of the commissioner of patents shows that 70,367 applications were filed in the year ended Dec. 31, 1913, that there are approximately 280,000 actions per annum on all applications and that there were 334 assistant examiners last year. Therefore each examiner handled an average of three and one-third actions per day, which gives but scant time for the searching examination which one would expect a patent to receive. Examination disclosed that the library of the Office is in very unsatisfactory condition, that the indexing of periodical literature was discontinued two years ago and that the appropriation made by Congress for books and periodicals is niggardly. The amount spent for the library in 1913 was $2,045. Probably the condition into which the library has fallen accounts for the indifference of the examiners toward it. Nevertheless, it is surprising that there are not standard-practice instructions prescribing the routine in examining into the merits of an application.

With these conditions in mind it is worth noting that the commissioner of patents has reported to Congress that the library is in need of reorganization and enlargement, that the material in the library is not and never has been in condition for ready reference and that much of it is practically unavailable for reference. He recommends that a salary more commensurate with the responsibilities be paid the librarian and his assistants and that members of the examining corps be given special library training in the Library of Congress. Furthermore, he requests an increase of ten in the examining force, and an increase in the number of the more highly paid positions, so as to make it possible to hold a higher class of men in the service. Finally, the crying need of better accommodations—a new building or an addition to the present structure—is again urged upon Congress.

In all these recommendations engineers, the industrial world and the public at large should uphold the hands of the commissioner. While the Office may be to blame in some degree for the conditions which make possible the granting of patents under circumstances similar to the autoclave test case, the fault in the last analysis is that of Congress. It has not given the Office proper support, and this in the face of the fact that the Office has to date turned into the United States Treasury $7,297,000 more than it has spent.

It should further be borne in mind that the present commissioner is not responsible for the practice of the Office. During his year of incumbency the Office has made greater progress than in any other similar period in its history. It can safely be predicted that many of the unsatisfactory practices will go by the board as soon as he can get around to them. For the maximum efficiency of the Office, however, he should have the items for which he has asked Congress. The Engineering Record trusts that its readers will stand back of the commissioner. By so doing they will not so much help him as they will insure a stricter administration of the patent law and come nearer obtaining full justice for both inventors and the public.

U. S. Army Camp Sanitation in Mexico

By WILLIAM C. GORGAS

Surgeon-General, U. S. A.

If there should be a call for volunteers to serve in Mexico, a general understanding of the fundamentals of camp sanitation and military hygiene would be of incalculable benefit in preventing a repetition of the epidemics which collected such an appalling toll in human lives during the war with Spain. It was with this in mind that the Engineering Record requested from Surgeon-General William C. Gorgas of the United States Army a statement outlining the plans which have been formulated to safeguard the health of our soldiers in tropical camps. Full publicity for these plans will forearm the men whose services may be needed with a knowledge of those first principles of camp sanitation and hygiene which are the foundation of any successful military operation. It is reassuring to learn from so distinguished an authority as General Gorgas, the man who made the Panama Canal possible, that the Medical Corps is prepared to maintain the health of the troops under the most adverse conditions.

—EDITOR.

IN the event of an invasion of a sub-tropical country by our Army the sanitary precautions to be observed by our troops would be of supreme importance. The neglect of them might indeed be fatal to the success of the campaign, just as the British in 1763 were compelled by disease to withdraw from Cuba after they had taken Havana. Our precautions must, however, begin at home in our assembly and concentration camps. There is no question but that this will be done, and all sanitary precautions that military exigency can permit will be observed in Mexico.

In the war with Spain in 1898 we were handicapped by lack of training and experience in camp sanitation. We had practically no experience in the tropics. While we had gone into Mexico in 1846, there was little of the knowledge then existing of tropical diseases that has been since accumulated in India, Africa, eastern Asia, and tropical America. Nor did the memory of what we may have learned in Mexico come down to us fifty-two years later. The great development of preventive medicine was not then in a stage convenient for practical application. The people were not educated up to its ideas. This is now all changed and the conditions under which we may go into tropical or sub-tropical lands give us considerable assurance, where before we went timidly and fearful of consequences.

AVOIDING CAMP DISEASES

In any contemplated occupation of a country lying partly in the tropics by an army coming from the temperate zone there would be two stages to consider with reference to the precautions necessary to the preservation of the health of such a command—first, the measures required to avoid the "camp diseases" in the homeland while the troops were mobilizing and training and, second, the measures required to avoid the diseases peculiar to the country to be occupied. It may be added that under the latter circumstances there might be camp diseases in the occupied country, the same as in the home country.

The first sanitary precaution is to secure healthy soldiers—physically sound men. Then it is necessary to safeguard their health while in training by giving them pure food, water and healthy camp surroundings and by preventing the entrance to such camps of infectious diseases. Our camps in this country would naturally be selected with a view to salubrity.

The supply of water must be given the same care and safeguarding that the supply of one of our cities receives. The selection of sites for large camps of concentration is influenced to a greater extent by this one matter than by any other consideration but military necessity. In successfully taking all precautions relating to water we assist in avoiding typhoid fever and the dysenteries—the camp diseases of all former wars. These diseases are also communicated by foods of some kinds, particularly the uncooked ones, and milk. Consequently the sanitary officers must inspect and examine the water and food, including milk, with the special purpose of keeping out the diseases thus transmitted. Of course, as these diseases are spread by contact, as well as mechanically by flies and possibly other insects, such methods of transmission must be watched for and prevented, principally by the early exclusion of all cases of these diseases. The means available to protect the camp water supply in semi-permanent camps in the home country are all those employed by intelligent civil communities.

In large, semi-permanent camps, when troops are assembled for the purpose of instruction and equipment awaiting transportation to the scene of campaign, it is usual to bring the water into camp and distribute it to the kitchens and shower baths by a fairly elaborate system of pipes. If the source of supply is good we have no more danger under the circumstances than we have in a small city.

POTABLE WATER IN ENEMY'S COUNTRY

When we have to deal with the question of potable water in the enemy's country, and especially in the field, we deal with a more difficult problem, but by no means a hopeless one. Efforts are made to ascertain the quality of the water by examinations and by its reputation when that is practicable. When deemed necessary—and this is the case with all surface waters in

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Inspection of Fifth Infantry, Showing Type of Field Service Tent Carried in Blanket Roll During March

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A Typical U. S. Army Camp, Showing Conical Tents Folded to Air Cots and Bedding

the tropics, unless we except some mountain streams—we try to render the water safe for drinking purposes by such measures as may be possible in the field. However, it will often occur that under military stress, lack of time and transportation troops for short periods must use the water that the natives depend upon. Under these circumstances we may look for the appearance of such diseases as are water borne.

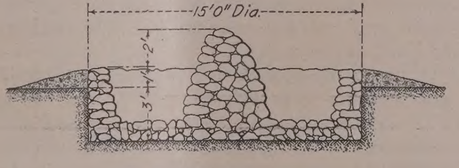
To Render Water Potable

The methods to render the water potable are naturally those used in temporary emergencies as a rule—boiling, filtering and the use of chemicals. Portable appliances are used in the Army to render the water safe. When this is not practicable we may always fall back upon boiling, for this may be actually done by the individual soldier with his metal cup as the receptacle. It has been found, however, that this is an impracticable and almost impossible procedure, as to accomplish such a measure requires fuel, the fire, time to boil and time to cool the water to enable it to be drunk. Either the soldier has, in the heat of the march or battle, to drink water as he finds it or some simple method has to be devised that may meet this necessity in a more practicable manner.

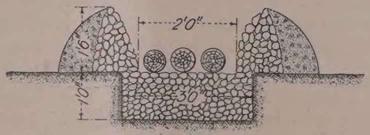
The field filter weighs 60 lb. and this limits its use to such columns as are provided with transportation to carry it about. The practical use of calcium chloride as a disinfecting agency is extensively used in cities. Its use in portable plants in suitable form for armies has not been satisfactorily worked out but promises a possible solution for this vexing question.

Only less important than a supply of potable water in camp is an efficient method for the disposal of human wastes. Excreta in camp become a most dangerous focus for the dissemination of such diseases as are spread through this means by direct contamination or pollution of water and milk and by flies. In the last large camps maintained by the Army in Texas in 1911 and 1913 a most efficient system was used. On still larger scale, but for a shorter time, the same system was in use at the Gettysburg reunion in 1913. Briefly, this consists for each company organization of a trench 16 to 20 ft. long, 2 to 2½ ft. wide, and 6 ft. deep. Over this is placed a box cover, which forms a seat with tight covers. The whole box fits the ground so closely and is so tightly made that flies are excluded. Each morning a gallon of oil and 15 lb. of straw are burned in this trench. This has the effect of destroying fly larvæ, incinerating the surface of the contents of the trench and its solid walls and deodorizing. For a year in the Texas camps this system has given complete satisfaction. It will be observed that again the distinction must be made between camps semi-permanent in character and the camp of troops actually in the field. For the latter, of course, no elaborate system is appropriate. Shallow trenches are used and covered after twenty-four hours. The facilities provided for the civil population are used when troops are in possession of towns and cities.

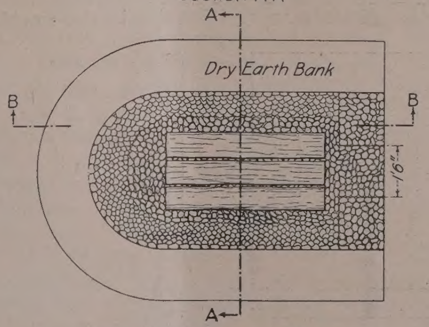
The use of deep trenches in camp is somewhat limited by the character of the ground. High ground water and rocky outcrops forbid their use. We can then use very satisfactory incinerators in semi-permanent camps. These are more expensive, as fuel is required. When a large camp is in the environs of a city with a sewerage system and is to be occupied for a considerable time connection may be made with the established city system. This was actually done during the past few months at Texas City.



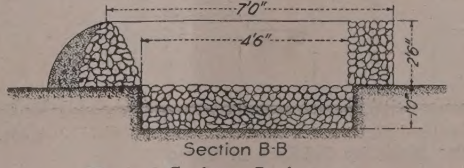
Rock Pile Crematory



Section A-A



Plan showing Logs in Place



Section B-B

Typical Garbage Incinerator

The system was devised by the Vaughn-Reed-Shakespeare board, which investigated the typhoid epidemics in the camps during the war with Spain. This is known as the Reed trough system, and is merely a galvanized-iron trough and urinal that contains a mixture of lime and water. As the excrement and urine are deposited into this they are not disturbed by flies. The contents of the trough are removed at intervals by an odorless excavator and deposited at a distance on fields as a fertilizer. This system is limited to weather conditions that do not reach the freezing point.

It has been an axiom in past wars that moving armies were healthy. This is merely an expression of the fact that moving troops get away from their own camp pollution. This is still true unless the troops in semi-permanent camps are protected from themselves by a sanitary system for the disposal of human wastes. To a lesser extent the other camp wastes are a menace to the health of troops, if neglected.

Flies, the spreaders of typhoid, dysentery and perhaps other diseases by mechanically carrying the organisms on their feet, breed in the droppings of the horses and mules, and also in kitchen wastes under ordinary conditions. It is necessary, then, to devise a method of gathering and destroying both stable sweepings and kitchen wastes. In camp the army has disposed of this by burning the sweepings after they are gathered at a dump and by burning right at the kitchen door the wastes therefrom. Moving troops in the field, as a rule, have no trouble with the disposal of these wastes, as they are so scattered that the amount constitutes no menace.

Sanitary Instruction for Recruits

In such an army as might be mobilized for service abroad we would expect some 120,000 regulars and twice as many volunteers. Of the regulars all but the recruits will average one to three years of experience that has taught them how to take care of themselves in the field and camp. Among the volunteers some considerable experience exists as a result of manœuver camps and the Spanish War—many veterans of that war being in the militia. The proportion of recruits will, however, be 50 to 75 per cent of the total strength, as far as experience in the field is concerned. There will be, therefore, a considerable proportion of green men to be taught camp sanitation, as well as given military instruction. Much of this will be given in concentration camps. Fortunately, most of the officers of the volunteers will be men who are impressed with the value of sanitation in the field. They and the regular officers and older soldiers will quickly instruct the new men in the habits so essential to health in camp.

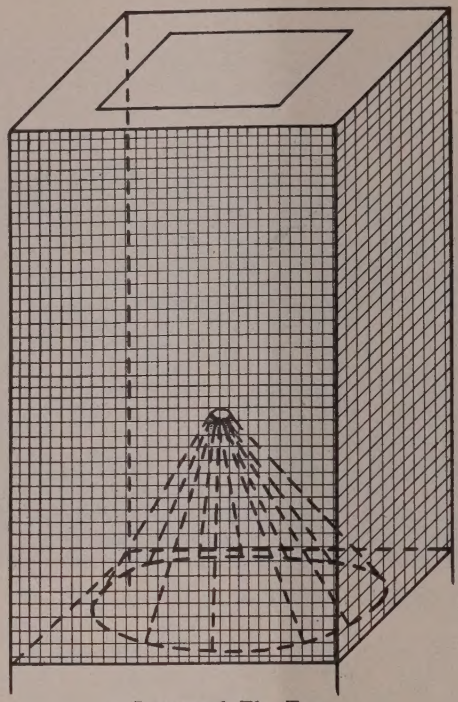
There exists, then, a yeast to leaven the whole that was absent in 1898. Since that eventful year the officers of the Medical Department of the Army have been studying and practising military hygiene and sanitation with brilliant results, as demonstrated in the two large camps in Texas. Here 10,000 men lived for a year at a time with a sick rate lower than that at the average post. Better yet, the officers of the line, impressed with the value of the lessons in camp sanitation, have been enthusiastic supporters of these advances and are hardly second to medical officers in their knowledge and experience in such matters. The Army, then, is in an entirely different position than at the outbreak of the Spanish War. The 20,000 cases of typhoid that then puzzled and distressed the people of this country will not reappear as spectres in our camps as a sign of sanitary incompetence.

ANTI-TYPHOID INOCULATION

Anti-typhoid inoculation, which has been in vogue in the Army since 1909, and which so efficiently protected it in 1913 that there was but one case among the inoculated in the army of 90,000, is to be trusted to keep our camps free of this disease so fatal to armies of the past.

The dysenteries will be held in abeyance by many of the precautions that prevent typhoid, particularly the safeguarding of water and the early exclusion of such cases from the camps.

Yellow fever is robbed of much of its terror by the fact learned in 1898 by Reed and his devoted band, which taught us the means of transmission and, consequently, the manner of avoiding it. The soldier carries in the field a mosquito-bar weighing 13 ounces that enables him to sleep in comfort and safety. The sentry on duty is provided with a head-net that serves the same purpose. These are the diseases that, if avoided, will make any campaign in the tropics unique in history.

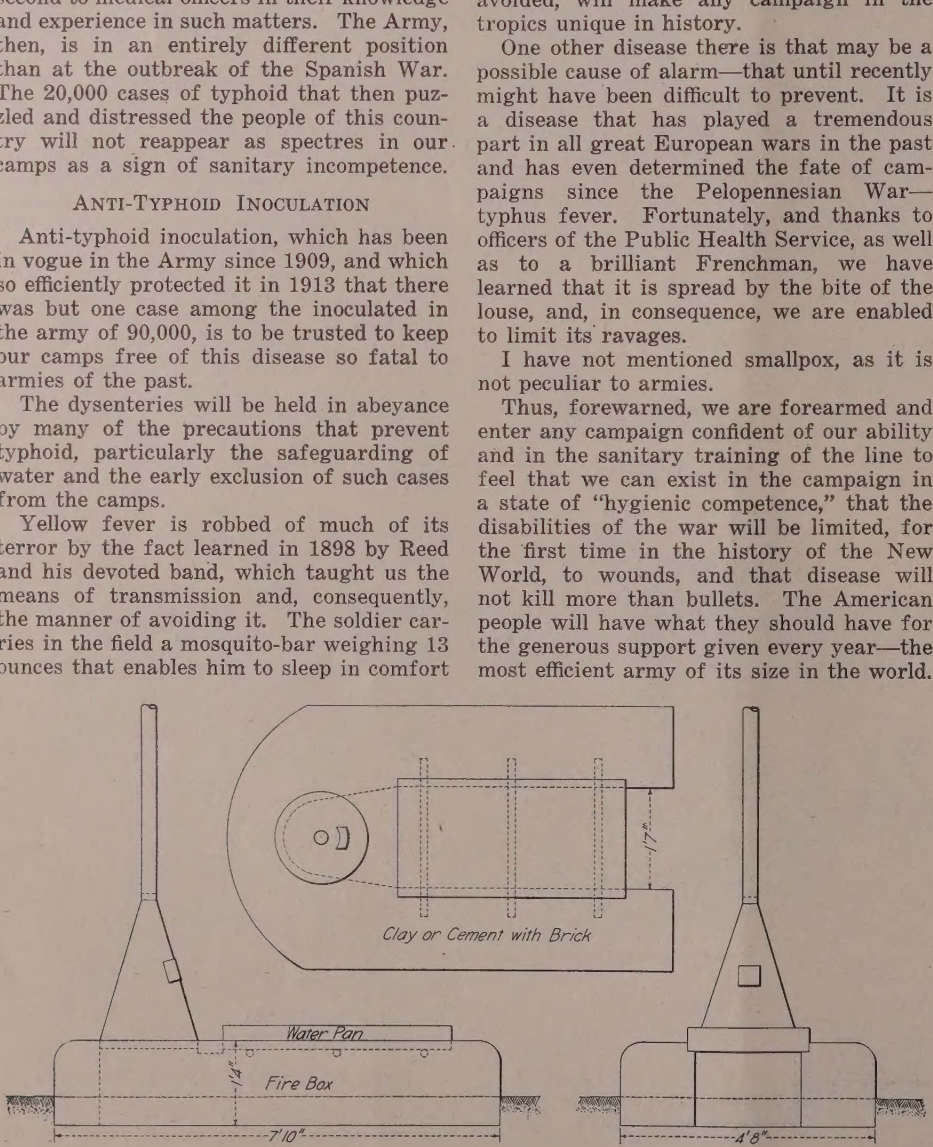


Improved Fly Trap

One other disease there is that may be a possible cause of alarm—that until recently might have been difficult to prevent. It is a disease that has played a tremendous part in all great European wars in the past and has even determined the fate of campaigns since the Pelopennesian War—typhus fever. Fortunately, and thanks to officers of the Public Health Service, as well as to a brilliant Frenchman, we have learned that it is spread by the bite of the louse, and, in consequence, we are enabled to limit its ravages.

I have not mentioned smallpox, as it is not peculiar to armies.

Thus, forewarned, we are forearmed and enter any campaign confident of our ability and in the sanitary training of the line to feel that we can exist in the campaign in a state of "hygienic competence," that the disabilities of the war will be limited, for the first time in the history of the New World, to wounds, and that disease will not kill more than bullets. The American people will have what they should have for the generous support given every year—the most efficient army of its size in the world.



Improvised Kitchen Incinerator Made by Soldiers in Camp

How the Autoclave Cement Patent Was Granted

Investigation by Engineering Record's Representative Discloses Neglect by Patent Office of Literature of the Art

SHORTLY after the issuance of the Force patent on the autoclave test for cement the Engineering Record (in the issue of Feb. 14, 1914) expressed its views as follows: "On what basis the office could grant the patent is difficult to imagine, for the fact that the high-pressure steam test is not new is known to everyone interested in cement testing. The matter surely must have been brought up in the correspondence between the Patent Office and the applicant for this patent. The papers would make interesting reading." On account of the storm of protest raised by the cement industry against the granting of this patent and on account, moreover, of a letter from the Bureau of Standards, printed below, recently received by this journal, it was determined to look into the records of the Patent Office to ascertain the thoroughness of the search and by what argument the patentee had convinced the office that his claims were valid even in the face of the voluminous literature in existence on the high-pressure cement test. This investigation was made last week with the results reported below.

The letter from the Bureau of Standards, above referred to, was received from Dr. S. W. Stratton, director of the bureau, in response to a letter from the editor of this journal asking the attitude of the bureau toward the autoclave test, since it is well known that the bureau is making studies along this line. Dr. Stratton's reply is as follows:

"We have been advised by counsel that section 4920 R. S. provides that:

"'In any action for infringement the defendant may plead the general issue, and having given notice in writing to the plaintiff or his attorney thirty days before, may prove on trial any one or more of the following special matters:

"'First. That for the purpose of deceiving the public the description and specification filed by the patentee in the Patent Office was made to contain less than the whole truth relative to his invention or discovery, or more than is necessary to produce the desired effect; or

"'Second. That he had surreptitiously or unjustly obtained the patent for that which was in fact invented by another, who was using reasonable diligence in adapting and perfecting the same; or

"'Third. That it has been patented or described in some printed publication prior to his supposed invention or discovery thereof, or more than two years prior to his application for a patent therefor; or

"'Fourth. That he was not the original and first inventor or discoverer of any material and substantial part of the thing patented; or

"'Fifth. That it had been in public use or on sale in this country for more than two years before his application for a patent, or had been abandoned to the public.

"'And in notices as to proof of previous invention, knowledge, or use of the thing patented, the defendant shall state the names of the patentees and the dates of their patents, and when granted, and the names and residences of the persons alleged to have invented or to have had the prior knowledge of the thing patented, and where and by whom it was used; *and if any one or more of the special matters alleged shall be found for the defendant, judgment shall be rendered for him with costs.* And the like defenses may be pleaded in any suit in equity for relief against an alleged infringement; and proofs of the same may be given upon like notice in the answer of the defendant, and with the like effect.'

"Paragraphs 3, 4 and 5 would appear to apply in this case, especially as the patent record files show that none of the data contained in the following references were given consideration.

"Patent 13,808, granted to Dr. W. Michaelis, May 14, 1881, by the German Empire, which covers substantially the exposing of hydrated cement with or without sand to steam under pressure at temperatures of 140 deg. to 180 deg. C (40 to 130 lb. pressure) and subsequently determining its strength.

"The following references contain descriptions and discussions of high-pressure steam and boiling tests as advocated by Michaelis, Erdmenger and others:

"Protokoll of Association of German Portland Cement Manufacturers, 1891, pp. 42, 43, 72, 80, 82, 83; 1893, pp. 90, 91; 1894, pp. 50.

"Tonindustrie Zeitung, 1881, pp. 506; 1892, pp. 1080; 1893, pp. 340, 392, 393; 1896, pp. 2, 4.

"Journal of Society of Chemical Industry, 1893. Spalding, Hydraulic Cements, 1897, p. 183. Redgrove and Spackman, London, 1905, p. 208. Cement Testing, by W. Purvis Taylor, 1906, p. 169.

"Ciments et Chaux Hydrauliques by E. Candlot, Paris, 1906, p. 301. Die Moderne Aufbereitung der Mortel Materialien, by Dr. Carl Schock, 1904, p. 391. Die Portland Cement Fabrikation, by Dr. Carl Naske, 1909, p. 331.

"Transactions, American Society of Civil Engineers, Vol. 30, p. 14. Institution of Civil Engineers, Vol. 114, p. 401. Transactions, Concrete Institute, Vol. 2, p. 39. Proceedings, American Society for Testing Materials, Vol. 2, 1902. Municipal Engineering, Vol. 12, 1897. Transactions, American Society of Civil Engineers, Vol. 27, p. 428, 497.

"Therefore we shall disregard the claims of this patent and continue to use the high pressure steam or so called 'autoclave' test as we may desire in our laboratory."

DOCUMENTS IN PATENT OFFICE

The original application for the Force patent was filed in the Patent Office under date of Sept. 13, 1912, and is entitled "Method of Treating Portland and Similar Cement." The claims made are as follows:

"I claim as my invention:

"1. The herein described method of preparing solid bodies of Portland and similar cement for testing the same which consists in boiling such cement bodies under pressure, substantially as set forth.

"2. The herein described method of preparing solid bodies of Portland and similar cements for testing the same which consists in subjecting such cement bodies to heat and pressure while in the presence of water, substantially as set forth.

"3. The herein described method of preparing solid bodies of Portland and similar cement for testing the same which consists in boiling such cement bodies under a pressure of approximately 285 lb. to the square inch, substantially as set forth."

This application was evidently acted on in February of the following year, for the next document in the case is a letter from the Patent Office to Mr. Force and his attorneys rejecting the claims for lack of patentability, since, as the Office stated, "they are claims for a process of determining whether bars of cement will stand a certain boiling operation by subjecting them to this operation. Moreover it is old to test cement by boiling at atmospheric pressure, as admitted by applicant and also as mentioned in a book entitled 'Portland Cement,' Richard K. Meade, 1911, pages 464 and 465. It is old in various arts to employ water or steam at high pressures."

MODIFICATION OF CLAIMS

Under date of March 10, 1913, Mr. Force substituted new claims for the first and second above mentioned, but the new claims differ only by the insertion of the words "higher than atmospheric" after the word pressure. He pointed out that the citation was an article on boiling at atmospheric pressure, and his attorneys in a final paragraph say: "Treatment of cement by boiling at a pressure in excess of atmospheric pressure seems to be new with this applicant and produces a solidifying effect which is quite different from that produced by boiling at atmospheric pressure."

The Patent Office under date of May 6, 1913, in replying to the above modification by Mr. Force, again rejected the claims and added:

"It is old to boil a specimen at atmospheric pressure. In view of this, and of the common use of higher pressures and temperatures in various arts, it would not be invention broadly to apply boiling at a higher pressure than atmospheric. If some particular pressure is found desirable, suitable limitation of statement should be made."

This letter from the Patent Office evidently opened to Mr. Force a new point of view, for his attorneys under date of May 22, 1913, asked the Office what it had in mind by the statement, "If some particular pressure is found desirable, suitable limitation of statement should be made." They also pointed out that a pressure of 20 atmospheres, or 285 lb., is mentioned in the specification and also in the third claim.

To this letter the Office did not directly reply, but it was learned on investigation that Mr. Force personally had gone to the Office and that much of the prosecution of the claims had been oral and is not shown by the records. In fact, the very next letter from the Office seems to take an entirely new track, for under date of July 30, 1913, the Office points out that the claims are for preparing cement bodies, while the argument is directed to the superiority of the cement thus prepared. Commenting upon this view the Office said:

"This is inconsistent with the purpose of the invention as indicated in the specifications and original claims. It would be obviously incorrect to prepare blocks of cement by a process adapted to confer superior strength, if these bodies were to be used in testing cement intended to be used in another way in practice."

In other words the Office here made the objection which is raised by engineers against accelerated tests, that they are irrational, making the approval of products depend upon a set of conditions bearing no relation to those under which the material must stand up in service.

Following this matter there appeared to be another hiatus in the prosecution of the case, doubtless due to a visit by Mr. Force to Washington, for without meeting the last mentioned objection the applicant on Sept. 29, 1913, substituted for the three previous claims the two which were finally granted and which are as follows:

"I claim as my invention:

"1. In the method of preparing solid bodies of Portland or similar cements for testing the same the herein described treatment which consists in boiling such cement bodies under a pressure which exceeds 50 lb. to the square inch.

"2. In the method of preparing solid bodies of Portland or similar cements the herein described treatment which consists in boiling such cement bodies under a pressure approximating 285 lb. to the square inch."

On Dec. 11, 1913, the Office wrote to Mr. Force saying that the case was ready for allowance and requesting a minor amendment. On Jan. 3, 1914, Mr. Force was notified that the patent had been allowed. It was issued Feb. 3, 1914, as patent number 1,085,977.

PROCEDURE OF PATENT OFFICE

It will be noted, therefore, that all of the preceding literature on the high-pressure boiling or steam tests was disregarded so far as the granting of this patent was concerned. The only citation from the literature of the art is not at all pertinent. The patent law specifically states that a patent shall not be granted provided the idea has been in use two years preceding the filing of the application, has been patented here or abroad, or has been described in foreign or American literature more than two years before the filing of the application. Naturally this extraordinary condition of affairs prompted further inquiry. Was the German patent, cited by Dr. Stratton, on file in the Patent Office? Did the library of the Office contain the books in which the references above given are found? Were the facilities of the library such that the examiner could readily have found the literature pertaining to the case?

The first question was readily answered, for the file of German patents in the Office included the Michaelis high-pressure steam patent. Moreover the Engineering Record's representative was informed that there was a satisfactory index to the German patents.

The next step in the investigation was to examine the card index maintained by the Office. Herein were found a number of cards on the high-pressure steam or boiling test. These were not listed by the investigator, but among them were references to one of Erdmenger's articles in the "Tonindustrie Zeitung," to articles by Spalding and by Taylor and to a reference in one of the volumes of "Proceedings" of the American Society for Testing Materials. Further examination disclosed that the Spalding, the Taylor and the Testing Materials references were on file in the library.

It appears, therefore, that the examiner did not thoroughly search the German patent literature and neglected entirely both foreign and American technical literature. Evidently, therefore, the Engineering Record was justified in wondering what the Patent Office records would show with reference to this case.

Having disclosed this most extraordinary condition with reference to the autoclave cement patent the Engineering Record's representative then requested the file covering the patent granted to Alexander G. Ney, of Aurora, Ill., for a "rock-like substance." This patent was granted in 1909 and is numbered 939,072. Without going into the involved claims, seven in number, it allowed Mr. Ney claims on the use of a wet concrete, a form evidently in use many years previous to the granting of his patent.

The condition disclosed by the documents in this case is even more extraordinary than those disclosed by the previous file. The file was void of any papers whatsoever, except the original application, the letter from the Patent Office allowing the patent and some other formal documents, regarding fees, etc. The original application is dated July 7, 1909, and was filed three days later. On Oct. 2, 1909, the Office sent Mr. Ney a notice that the patent had been allowed and the patent itself was issued on Nov. 2, 1909. There is no citation whatsoever against the claims in the patent, despite the fact that the literature on the subject is very full. Evidently there had been no search of either the foreign or domestic literature.

Conclusions

The conclusions one must draw from the conditions above cited are a severe condemnation of the Patent Office. There are, however, certain extenuating conditions which should be borne in mind and which will be found discussed editorially in this issue. To any one acquainted with the art there is no doubt that these patents have been granted contrary to the intent of the patent law. The fixing of the blame must be done after considering other factors than those presented in this account. The reader, therefore, is referred for final conclusions to the editorial appearing on page 547.

It may be noted, finally, that the Ney patent on wet concrete was declared invalid by Judge Sanborn in the District Court of the United States for the Northern District of Illinois, Eastern Division, on Nov. 12, 1913, in a suit brought by Mr. Ney against the City of Aurora. The invention was declared invalid because the method had been in common and almost universal use more than two years prior to the date of the application.

Lowering Stone by Means of a Wire-Rope Incline

A WIRE-ROPE incline 6000 ft. long, with two curves, is used to lower stone down Table Rock Mountain, near Boise, Idaho. The mountain rises 900 ft. above the river at its base, and on the summit is a ledge of sandstone said to be of fine quality for building purposes. Quarries have existed on this ledge for many years, and it was the difficulty in getting this stone down the mountain that led the Boise Stone Company some years ago to build the incline. Except at the bottom, where the line branches out into two two-rail tracks to allow cars to pass, the incline is a single three-rail track, which is virtually a double track, one car running on the first and second rails and the other on the second and third—each car controlled by a single cable on rollers between its corresponding rails. Leschen plow-steel cables 1⅜ in. in diameter are used. They are operated by drums 9 ft. in diameter. The cars are of 25-ton capacity.

Appraisal of Lehigh Valley Railroad

Abstract of Comprehensive Report by William J. Wilgus on Evaluation of the Physical Property Made under His Direction for the Company

COMMENT has already been made in this journal on the fact that the recent appraisal of the Lehigh Valley Railroad for the company showed a value nearly double the capitalization. The work was done under the direction of William J. Wilgus, consulting engineer, of New York City, and formerly vice-president and chief engineer of the New York Central & Hudson River Railroad. In his report, from which these notes are taken, he sets forth underlying principles of valuation, describes the methods employed in this particular appraisal, presents his results according both to Interstate Commerce Commission and to territorial classifications, and in a series of appendices enlarges upon various phases of the work and explains why his total is so far in excess of the capitalization of the road. His diagnosis of the general principles of evaluation, and of the reasons why reproduction cost new is the only proper basis, accord with his presentation of the subject last year before the American Society of Civil Engineers—which was abstracted in the Engineering Record in the issues of June 14, 1913, page 654, and June 21, page 692.

A careful physical valuation of the property owned or controlled and used or held for the purposes of a common carrier by the Lehigh Valley Railroad, shows that its estimated cost of reproduction new, as a going concern actively engaged in handling the current volume of traffic as of Jan. 1, 1914, is fully $324,478,300.

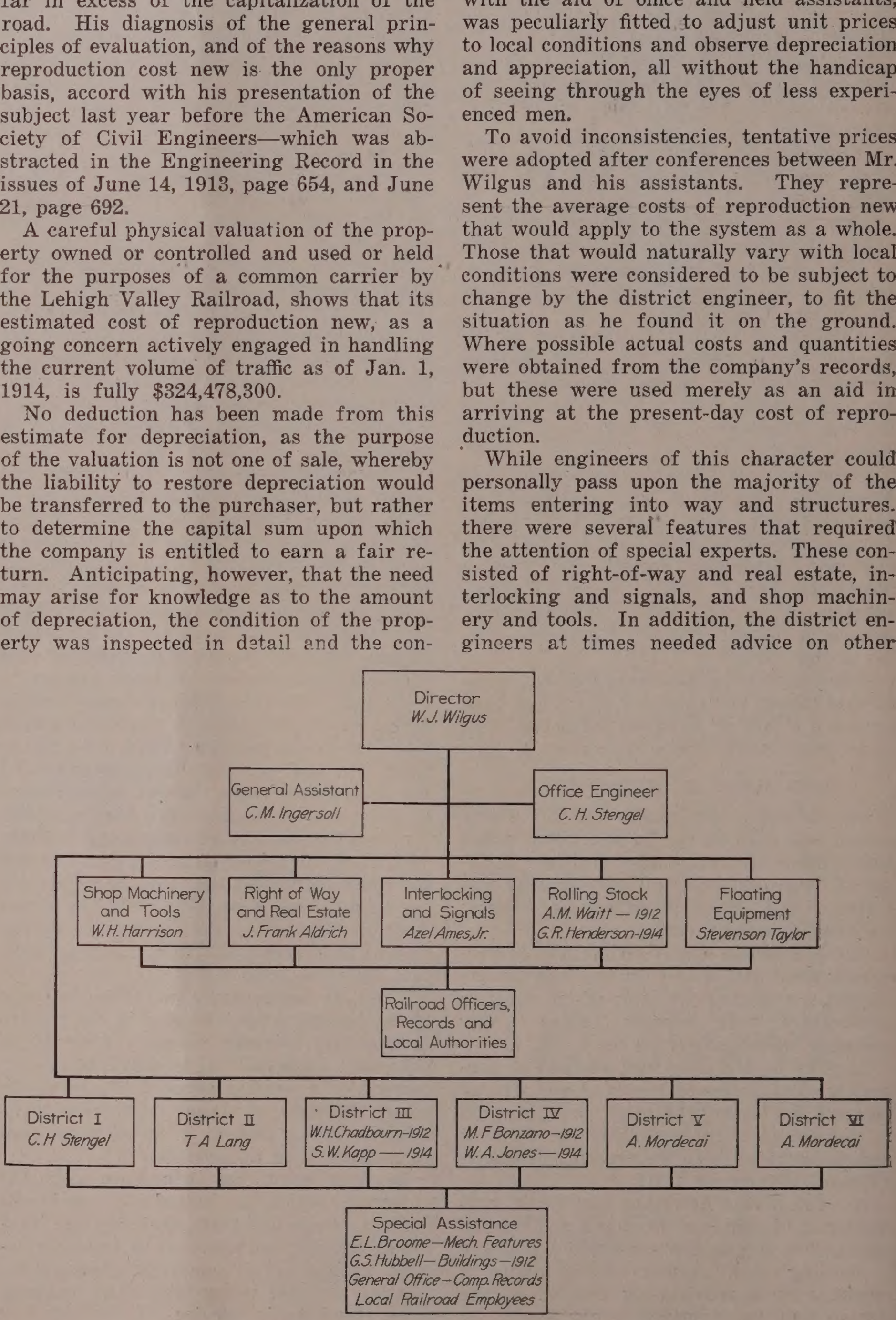
No deduction has been made from this estimate for depreciation, as the purpose of the valuation is not one of sale, whereby the liability to restore depreciation would be transferred to the purchaser, but rather to determine the capital sum upon which the company is entitled to earn a fair return. Anticipating, however, that the need may arise for knowledge as to the amount of depreciation, the condition of the property was inspected in detail and the conclusion reached that the sum required to offset net depreciation as of Jan. 1, 1914, is approximately $26,688,759. The depreciation thus estimated is the normal result of ordinary usage, and is inseparable from any well maintained going concern like the Lehigh Valley Railroad.

Organization

The valuation corps was organized in much the same way that would be done in the actual building of a railroad. For the valuation of "Road," as defined by the Interstate Commerce Commission classification, six districts were laid out, each under the charge of an engineer of wide experience in the responsible direction of maintenance and construction of railroads, who, with the aid of office and field assistants, was peculiarly fitted to adjust unit prices to local conditions and observe depreciation and appreciation, all without the handicap of seeing through the eyes of less experienced men.

To avoid inconsistencies, tentative prices were adopted after conferences between Mr. Wilgus and his assistants. They represent the average costs of reproduction new that would apply to the system as a whole. Those that would naturally vary with local conditions were considered to be subject to change by the district engineer, to fit the situation as he found it on the ground. Where possible actual costs and quantities were obtained from the company's records, but these were used merely as an aid in arriving at the present-day cost of reproduction.

While engineers of this character could personally pass upon the majority of the items entering into way and structures, there were several features that required the attention of special experts. These consisted of right-of-way and real estate, interlocking and signals, and shop machinery and tools. In addition, the district engineers at times needed advice on other



Organization Chart for the Lehigh Valley Evaluation specialties, such as heating, lighting and power plants in shops and engine houses, and important or unusual structures.

The right-of-way and real-estate expert was required to be one of wide experience in the purchase of land for railroad purposes, with an intimate knowledge of railroad land values in the East. He was expected to ascertain the current values of neighboring lands as a means of measuring the value of the railroad properties, make inquiries of local real-estate agents and others familiar with the subject, and in finally fixing values, to take into account the increment that experience has taught should be added in each case for railroad purchases and plottage.

It was believed that this method of ascertaining the reproductive cost of right-of-way and real estate through the central agency of a man having this comprehensive knowledge of the values of land purchased and used for railroad purposes would avoid the inconsistencies and errors that are common where the work is entrusted to a multitude of local men unversed in the broader aspects of the problem.

LAND

Three methods of valuing land were considered: Original cost, basic cost with no added allowance for damages, and reproductive cost. The first method was impracticable for the reason that the records were generally incomplete or could not be found. Basic value of railroad right-of-way is the present average normal worth of neighboring whole tracts, from which is estimated the reproductive cost of severed or assembled parcels required to produce the right-of-way. The use of this value is deemed inequitable in that where there has been little growth of land values the estimated figures may be less than those actually paid. Hence it has seemed proper to use the reproductive method in all cases. The adoption of this method on the Lehigh Valley has resulted in the addition of an average of but 50 per cent to the basic value for the entire road, and it is believed that this is a very conservative estimate of what it would cost to reproduce the right-of-way and real estate of the company at this time.

Rolling stock and floating equipment, as defined by the Interstate Commerce Commission, were each placed under the charge of an engineer of standing in his specialty. They necessarily could not personally view each locomotive, car and boat, but they inspected a sufficient number of each class or type, in connection with the company's complete records as to use and maintenance of all equipment, to be able to fix their value and condition.

Provision for engineering, for contingencies, for general expenditures as defined by the Interstate Commerce Commission covering all three states of construction, and for working capital and stores, was made. Overhead charges aggregate 30.74 per cent of the estimated cost of the measurable items, whereas the use of a higher rate of 35.37 per cent would have been entirely justifiable through the employment of a rational in place of the empirical or usual method of calculating interest charges. These percentages are in contrast with approximately 40 per cent in the Buffalo, Rochester & Eastern and the Virginian Railway cases.

Forms and tables were prepared for facilitating and checking office and field work. With these, estimates were detailed and summarized in subdivisions of suitable length, and then again summarized into branches and main line or into taxing districts, as might be desired, all in accordance with the classification of the Interstate Commerce Commission.

Territorial valuation was considered necessary so that the results might be utilized at will in the future consideration of various routings of traffic, and also in verifying values for different purposes. Moreover, the ascertainment of cost per mile by subdivisions made possible a close general check on the accuracy of the work.

While quantities were taken as of Jan. 1, 1914, this was not considered feasible for unit prices subject to violent fluctuations that should be averaged over a past period of several years.

The valuation work was originally done between Nov. 15, 1911, and April 30, 1912, and the revaluation bringing the results down to Jan. 1, 1914, was commenced in August, 1913, and completed March 20, 1914.

RESULTS

The results of the valuation of the road as a whole are summarized in the accompanying tables.

Territorially the costs per mile vary widely. The terminal costs per mile at Jersey City and Buffalo are respectively $2,246,103 and $1,945,429. The 54-mile section from the Delaware River to Penn Haven Junction, which includes 66 miles of third and fourth track, figures $467,744; the 92-mile section from Geneva to Depew is only $116,633. The average for the whole double-track main line from Jersey City to Buffalo, 447 miles, is $278,898. These figures exclude equipment. The last amount compares with the $292,360 per mile, exclusive of equipment, estimated by the New York Public Service Commission, Second District, as the cost of the Buffalo, Rochester & Eastern Railroad, which it was proposed to build from Buffalo to Troy. For the branch lines, which are mostly single track, the costs per mile are much lower, the lowest being only $20,741. For the entire road the cost per mile is $166,086; adding to this $63,222 per mile for equipment and $6,542 for working capital, the total for the road complete is $235,850 per mile. This figures $154,485 per mile of single main track.

These figures do not include the value of intangible property, such as franchises (apart from street and stream crossings) and equities that the company may possess through trackage rights over foreign lines.

The large difference between the cost of

TABLE 1—SUMMARY OF VALUATION ACCORDING TO INTERSTATE COMMERCE COMMISSION CLASSIFICATIONS

Road	Cost of reproduction new	Percentage of general account	Percentage of grand total	Appreciation	Depreciation	Net depreciation
1. Engineering (5 per cent of items 4 to 36)	$4,763,414	2.78	1.47	....	....	....
2. Right-of-way and station grounds	57,428,956	33.46	17.70	....	....	....
3. Real estate	14,145,662	8.24	4.36	....	....	....
4. Grading	24,452,659	14.25	7.54	$3,853,377	$31,662	*$3,821,815
5. Tunnels	2,226,199	1.30	0.69	....	2,627	2,627
6. Bridges, trestles and culverts	13,922,570	8.11	4.29	....	324,869	324,869
7. Ties	8,088,592	4.71	2.49	....	3,591,525	3,591,525
8. Rails	12,487,794	7.28	3.85	....	2,411,944	2,411,944
9. Frogs and switches	990,289	0.58	0.31	....	327,987	327,987
10. Track fastenings and other material	2,607,174	1.52	0.80	....	645,380	645,380
11. Ballast	3,387,917	1.97	1.04	590,757	878	*589,879
12. Track laying and surfacing	4,288,894	2.50	1.32	....	....	....
13. Roadway tools	90,940	0.05	0.03	....	19,724	19,724
14. Fencing right-of-way	437,104	0.25	0.13	....	191,910	191,910
15. Crossings and signs	960,449	0.56	0.30	2,640	114,649	112,009
16. Interlocking and other signal apparatus	2,162,844	1.26	0.67	....	289,946	289,946
17. Telegraph and telephone lines	584,636	0.34	0.18	....	46,254	46,254
18. Station buildings and fixtures	2,329,324	1.36	0.72	....	335,109	335,109
19. General office buildings and fixtures	337,042	0.20	0.10	....	42,485	42,485
20. Shops, engine houses and turntables	4,520,813	2.63	1.39	....	540,932	540,932
21. Shop machinery and tools	1,653,147	0.96	0.51	....	563,226	563,226
22. Water stations	697,022	0.40	0.21	....	83,961	83,961
23. Fuel stations	342,898	0.20	0.11	....	61,782	61,782
24. Grain elevators	297,802	0.17	0.09	....	17,003	17,003
25. Storage warehouses	321,399	0.19	0.10	....	97,768	97,768
26. Dock and wharf property	5,172,471	3.01	1.59	....	1,052,902	1,052,902
27. Electric-light plants	13,434	0.01	0.01	....	6,999	6,999
28. Electric power plants	....	....	....	....	....	....
29. Electric power transmission	....	....	....	....	....	....
30. Gas-producing plants	17,841	0.01	0.01	....	197	197
31. Miscellaneous structures	2,916,461	1.70	0.90	....	1,016,686	1,016,686
32 to 36. Included in foregoing items	....	....	....	....	....	....
Total, items 1 to 36	$171,645,747	100.00	52.91	$4,446,774	$11,818,405	$7,371,631
Equipment						
37. Steam locomotives	15,352,925	20.63	4.73	....	$5,487,031	$5,487,031
39. Passenger-train cars	4,657,400	6.26	1.43	....	429,957	429,957
40. Freight cars	47,632,212	64.00	14.68	....	9,473,766	9,473,766
41. Work equipment	1,135,480	1.52	0.35	....	349,322	349,322
42. Floating equipment	5,649,100	7.59	1.74	....	1,955,125	1,955,125
Total, items 37 to 42	$74,427,117	100.00	22.93	....	$17,695,201	$17,695,201
Contingencies						
Ten per cent of items 1 to 36 and 5 per cent of items 37 to 42—an average of 8.49 per cent of items 1 to 42	$20,885,935	100.00	6.44	$444,694	$2,066,621	$1,621,927
General Expenditures						
43. Law expenses 44. Stationery and printing 45. Insurance ... } ½ per cent 46. Taxes (1 per cent) 47. Commissions (2 per cent) 48. Other expenditures (1½ per cent) } 5 per cent	$13,347,955	27.51	4.11	....	....	....
47. Interest (average† 12.55 per cent)	35,171,546	72.49	10.84	....	....	....
Total, items 43 to 48	$48,519,501	100.00	14.95	....	....	....
Total Road, Equipment and General Expenditures	$315,478,300	....	....	$4,891,468	$31,580,227	$26,688,759
Working Capital and Stores	9,000,000	....	2.77	....	....	....
Grand Total	$324,478,300	....	100.00	$4,891,468	$31,580,227	$26,688,759

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*Net appreciation.

†Including working capital, 12.16 per cent.

reproduction new and the company's book costs is found to be due to:

(a) Capital eliminated in foreclosure proceedings, reorganizations, and absorptions.

(b) Equipment depreciation charged off on the books.

(c) Additions and betterments and other improvements not charged on the books to capital.

(d) Increment in value of lands.

(e) Use of the "going" company's facilities for which it has not been usual with the Lehigh Valley Railroad Company to make a charge against capital, such as use of equipment, transportation of men, tools and material, and shop and office facilities.

(f) Engineering, and general expenditures as defined by the Interstate Commerce Commission, including interest on money during construction, for which adequate charges have seldom if ever been entered against the capital account. These items aggregate a very large sum, amounting in this case to $53,282,915, or 20.3 per cent of what may be termed the measurable items plus contingencies. The propriety of including these items has been widely recognized, as in the Michigan, Wisconsin and Minnesota rate cases, and in the Rochester Corning Elmira Traction Company and the Buffalo, Rochester & Eastern cases before the Public Service Commission of the State of New York. In the latter case the commission added 29.5 per cent as compared with 20.3 per cent used in this appraisal.

In conclusion it may be said that these estimates have been made in painstaking detail by experienced engineers, specially versed in railway construction and maintenance, and guided by a spirit of conservatism in the determination of debatable points. Moreover it has been borne in mind that the purpose has been to arrive at the cost of construction, not of a series of inert lines unresponsive to large traffic demands, nor to the gradual expansion of a company already alive and self-supporting, but rather to the creation *de novo* of a vitalized, homogeneous system of transportation, equipped, manned and trained for the same character of service that is now efficiently performed by the Lehigh Valley system.

TABLE 2—ANALYSIS OF COSTS FOR THE "GOING" CONCERN

			Per cent of meas. items	
Measurable Items:				
Road:				
Right-of-way and station grounds				$57,428,956
Real estate				14,145,662
Total lands				$71,574,618
Other items				95,307,715
Total				$166,882,333
Equipment				74,427,117
Total				$241,309,450
Overhead Charges:				
Engineering	....	$4,763,414 equals	1.97	
Contingencies:				
Road	$17,164,579			
Equipment	3,721,356			
		20,885,935 equals	8.66	
General expenditures:				
Road	$9,440,532			
Equipment	3,907,423			
		13,347,955 equals	5.53	
Interest:				
Road	$30,248,192			
Equipment	4,923,354			
		35,171,546 equals	14.58	*74,168,850
Total exclusive of working capital and stores				$315,478,300
Working capital and stores				9,000,000
Grand total				$324,478,300

Mileage: Route, 1,375.78; single main tracks, 2,100.38; sidings, 1,139.25; all tracks, 3,240.36.

Road cost per mile, exclusive of equipment: Route, $166,086; single main track, $108,789; all tracks, $70,517.

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*This is 30.74 per cent of the measurable items.

Ultra-conservatism in the fixing of unit prices and overhead percentages has in this case resulted in what is believed to be an under rather than an over-valuation. Had advantage been taken in many instances of justifiably higher prices and charges, the estimates would have been considerably larger.

Unit Prices

The tentative unit prices adopted are based on the practice of Mr. Wilgus, adapted to average conditions on the Lehigh Valley Railroad after consultation with his assistants and with the chief engineer of the company, and following a study of the company's records. They have been used, except in those instances where the local conditions were such as to call for modifications.

Normal or basic land values have been secured from local authorities. To these have been added amounts to cover the increased cost that the experience of the expert retained for this purpose has shown are necessarily incurred in the acquisition of railroad lands, because of severance and other damages, and the disposition of owners to exact as much as possible for that which they know the purchaser must acquire. The factor that has been used in determining the added amounts for damages, etc., varies according to the locality and surrounding conditions. In cities the increase averages 44 per cent, in villages 103 per cent, in country districts 119 per cent, and on the entire system 50 per cent. These figures are averages for both right-of-way and real estate, the latter usually bearing a much smaller factor than the former. The adopted prices do not include engineering and legal expenses, nor costs of condemnation, salaries and expenses of right-of-way agents, building removals, commissions to agents, fees and payments for abutting damages. For these costs of acquisition percentages ranging from 1 to 5 per cent have been added to the estimated compensation to owners.

While the tentative excavation prices may be used as a general guide, they require local modification so as to harmonize with topographical and geological conditions that vary over a large system. The modifications made took into consideration the division of the territory into construction districts attractive to high-grade contractors with followings of sub-contractors. The tentative masonry and steel prices were in general used without change. Each of the four tunnels on the system was studied individually to determine the correct prices. Addition of freight rates to the costs at the mills of rails, frogs, switches and track fastenings caused a wide variety of prices for these materials. A number of charts were compiled to show the fluctuating prices of different materials and facilitate the determination of correct average prices.

Overhead Charges

To the measurable items embraced in the Interstate Commerce Commission accounts must be added certain percentages for overhead expenses which experience has shown are necessary for the inception and creation of the enterprise. These overhead charges are: Engineering, classified as account 1 and applicable to all of the road items with the exception of 2 and 3; contingencies, applicable to all items embraced under road and equipment; general expenditures, exclusive of interest, applicable to all of the Interstate Commerce Commission items, including the proportion added thereto for contingencies; and interest during construction, applicable to all of these items, including the foregoing percentages.

Taken as a whole, the ratio that the overhead charges, including engineering, contingencies and general expenditures, bear to the measurable values in the Lehigh Valley and other recent cases are indicated in Table 3.

Engineering

General practice varies somewhat as to the proper percentage that should be added to cost of construction for railroad engineering, the usual limits ranging from 4 to 5 per cent and upward. The former rate may be proper in the West, but is insufficient in the East, where salaries and expenses are higher, and where there exists a greater demand for the better grades of talent, because of the more intricate problems that arise in a thickly settled community and on a complicated system like the Lehigh Valley. On public works the percentages have ranged from 5 to 10 per cent and upward.

Contingencies

An inventory of the items entering into the construction of the Lehigh Valley must necessarily have missing much that is invisible to the eye, through covering of snow and vegetation, concealed foundations, mine and swamp settlements, road changes and similar causes. There is the certainty of claims for damage to adjacent land owners, personal injuries, contractors' extras and losses and other legal complications and disputes. Loss and damage for which the company is liable always occur during construction, as from failures of structures, washouts and floods and errors of officers and engineers. Delays are sure to arise, adding to the expense of construction, as for instance from strikes, and dif-

TABLE 3—RATIO OF OVERHEAD CHARGES TO MEASURABLE VALUES

Case	Per cent
Lehigh Valley valuation as reported	30.74
Lehigh Valley adding shortage in interest charges	35.37
Virginian Railway (approx.)	39.8
Buffalo, Rochester & Eastern	40.3
Western Pacific Railway	Very large

ficulty in obtaining material, labor and right-of-way.

Finally there is always the danger of a rising market for materials and labor, and of scarcity of high-grade contractors. The experience of Mr. Wilgus and others has shown that an addition of from 15 to 20 per cent to carefully prepared preliminary estimates is none too large. The instances are many where enterprises have underestimated their cash needs, through inadequate allowance for contingencies, with disastrous financial results, as in the instance of the Western Pacific Railway.

It may be said that the knowledge gained from the study of a completed system like the Lehigh Valley largely eliminates elements of contingency. This is true of features like classification of excavation, adequacy of waterways and miscellaneous items often forgotten in a preliminary estimate; but the largest elements of chance still remain, such as damage suits, delays, rising markets, scarcity of contractors, and many omissions. In many cases on the Lehigh Valley the appraised figures, including the provision for contingencies, have been found to be less than actual cost, where the latter has been ascertainable from the books. There is also the further item, unprovided for elsewhere, of maintenance of tracks and structures pending the commencement of operation.

Although some of the uncertainties that apply to road are absent in the case of equipment, there are others to be considered, as for instance engineering and inspection elsewhere unprovided, spare parts, and the expense of "breaking in" and caring for cars, locomotives, boats and vessels preliminary to placing them in service.

It should be added that beyond the allowance made under "general expenditures" for general officers and clerks, no special provision has elsewhere been made for the expense of manning and training the system in readiness for the safe, prompt, and economical handling of the volume of traffic now enjoyed by the Lehigh Valley.

GENERAL EXPENDITURES

The Interstate Commerce Commission classification of expenditures for road and equipment provides for the charging of the following items to "general expenditures": (43) Law expenses, (44) stationery and printing, (45) insurance, (46) taxes, (47) interest and commissions and (48) other expenditures. It has been usual in the valuation of public utilities to fix arbitrarily a percentage of the total cost to cover these items. In this instance an attempt has been made to analyze them and reach a result that may be said to have a logical basis.

In 1913 the amounts charged to the first three of these items, including allied subjects in connection with the operation of the railroad, aggregated, in round figures, $290,000. During construction the legal expenses would largely exceed those usual under normal conditions. Assuming that $400,000 would represent the annual cost at the termination of a six-year period, the average annual cost would be $200,000, or a total sum of $1,200,000, equivalent to a percentage of, say, ½ per cent.

The accrued taxes in 1913 amounted to approximately $1,447,205. This included taxes on gross earnings, capital stock, bonds and property. Assuming full taxes of $1,450,000 annually for one-half a period of four years, or, say, $2,900,000, the percentage would be about 1 per cent.

Interest during construction was treated separately. Discount on bonds was ignored, on the theory that pure discount is equivalent to an adjustment of the interest rate to current market conditions. A banker's commission for the sale of securities, however, was included, since payment for the services of those undertaking the sale of stocks and bonds seems to be just as legitimate and necessary as compensation for other services incident to the carrying out of the project. The usual allowance for this item is a percentage of, say, 2 per cent.

In 1913 the cost of salaries and expenses of general officers and clerks on the Lehigh Valley, including incidentals, was more than $550,000. Assuming that this amount will be applicable to an average of one-half a period of six years, the total would be $1,650,000, or, say, ½ per cent on the total cost. In addition to this there would be the further payment due to those who, through their initiative, originality, ability, and assumptions of responsibility of final success, would give life to the enterprise. One per cent would be moderate compensation for services of this kind. In the Rochester-Corning-Elmira Traction Company case the New York Public Service Commission advocated 5 per cent. Therefore the item of other expenditures would aggregate 1½ per cent, and the grand total of items 43-48, exclusive of interest, would be 5 per cent.

INTEREST DURING CONSTRUCTION

It is generally conceded that interest on money during construction is as much an element in arriving at the cost of the reproduction of a railroad, as expenditures for any other purpose in achieving the same result. It has been customary to take the estimated cost, at the adopted rate of interest, for one-half the assumed period of construction. This treatment is on the theory that the expenditures will increase in a constant ratio, or straight line, from nothing at the beginning to the full amount at the end of the constructional period; that money advanced to the company is non-interest bearing until actually disbursed; and that no interest is paid on the interest payments.

The securing of capital for a new untried enterprise is always difficult, and the rate of interest higher than for going concerns. Even in a case like the Western Pacific, whose 5-per cent bonds are guaranteed by the Denver & Rio Grande, the yield at current market prices in 1911 was slightly over 6 per cent. The five-year notes of the Tidewater Company were marketed on a 6 to 7-per cent basis, and the same may be said of other companies of established standing. With no support from a railroad of demonstrated earning power, 6 per cent seemed to be the minimum rate that could properly be applied to the construction period, especially as no provision was elsewhere made for discount on the sale of securities. This rate was adopted in the State valuations of Michigan, Nebraska and Wisconsin, and in determining franchise values in New Jersey.

The time that would elapse between the date of initiation of the project and the date of final completion varies with the locality, character of construction and nature of traffic. Important enterprises frequently take several years for the initial stage, from one to three or more years for actual construction, and a year or more for the third stage of education, adaptation and cultivation of traffic. With the desire to err, if at all, on the side of conservatism, the Lehigh Valley system was studied in detail and the respective stages timed as shown in Table 4.

TABLE 4—ESTIMATED TIME IN YEARS NEEDED TO REPRODUCE THE LEHIGH VALLEY

Item.	Main line	Principal terminals	Sub-main lines	Principal branches	Main branches
Initiation	1	1	1	1	1
Acquisition of right-of-way	1	1			
Construction	3	2	2	1	1
Educational and development period	1	1	1	1	
Total	6	5	4	3	2
			Per cent		
Interest charges based on full 6 per cent rate for half of period	18	15	12	9	6

On equipment it was assumed that deliveries would start one year before the termination of construction proper, and end one year thereafter, or a total period of two years, during which the average interest charge for one-half the time would be 6 per cent.

CUSTOMARY METHOD OF CALCULATION

By the customary method of taking the adopted rate of interest for one-half the above-mentioned periods of construction, the resultant sum for interest charges during construction was 12.55 per cent. Dividing this amount by three (one-half of the 6-per cent rate), the average period of construction for the entire system was found to be 4.18 years.

An analysis of the Lehigh Valley situation shows that this customary method of calculating interest charges, applied separately to each group having an assumed minimum period of construction, yields in the aggregate a result very much lower than would actually occur in a reproduction of the system, for the following reasons:

1. The expenditures would not increase in a constant ratio. In the preliminary stage the rate of expenditures would be small. Then there would be a marked rise for two years because of heavy right-of-way payments, followed by a somewhat decreasing rate for a year. Finally the rate would again increase by reason of large payments for equipment. The result in the aggregate is a much larger volume of expenditures in the early stages of the work than appears from the straight-line method, and therefore the interest charges are heavier.

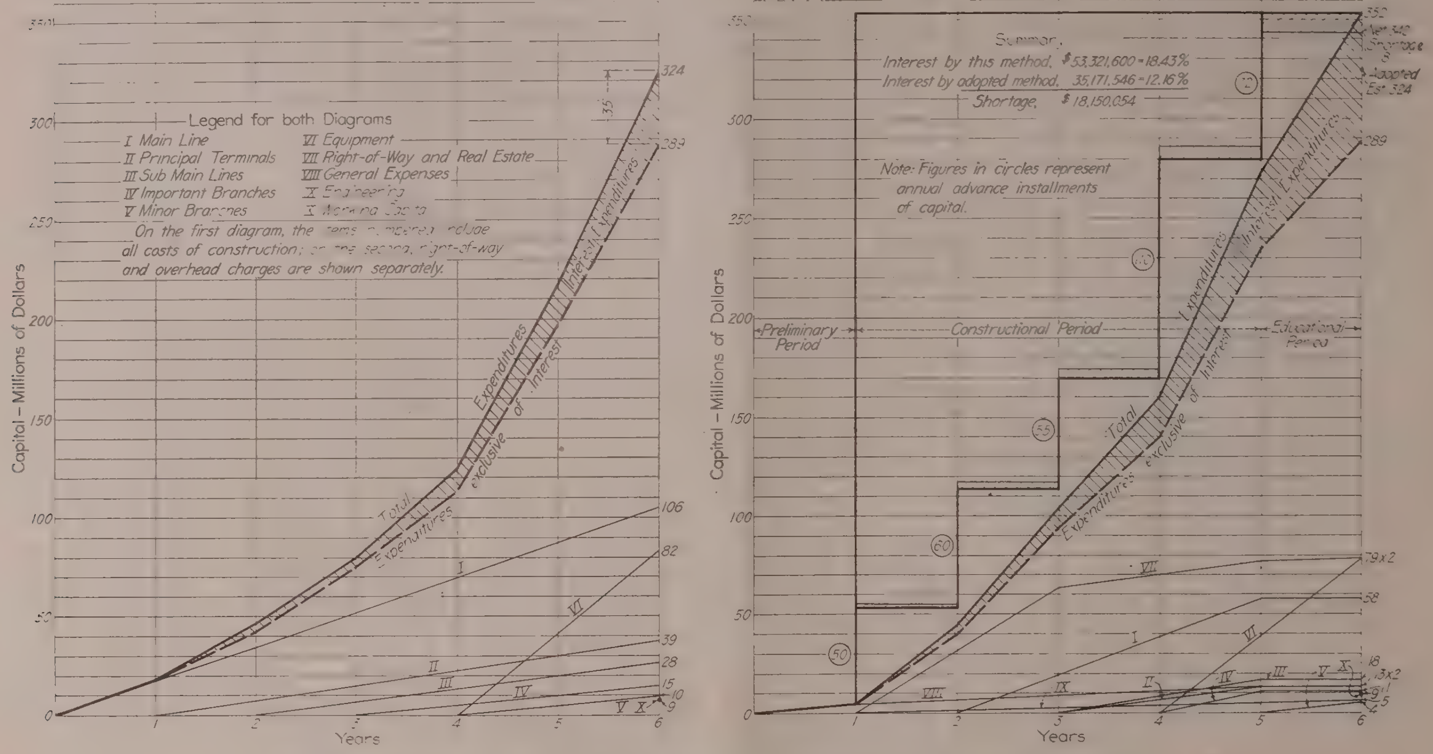
2. Securing of capital on a basis that will assure its delivery exactly as needed for disbursement during the progress of the work is not practicable. Stringency in the money market, or other unforeseen contingencies, make imperative the possession by the company of ample funds to bridge over temporary crises, even when the funds are supplied through banking houses of unquestioned strength. Either the entire amount must be taken at the time of financing, or the capital must be advanced in annual installments. In both cases the unemployed surplus over current needs is loanable at rates materially less than those paid by the company, the effect of which is an addition to the burden of interest charges during construction.

3. Interest charges must be paid from the capital which itself is interest-bearing, and therefore it is not proper that interest

on the interest should be omitted from the calculation of this item of cost.

Explanation of Diagrams

The accompanying diagrams show graphically the difference between the usual method of calculating interest charges, which was adopted in the Lehigh Valley valuation, and the correct method. In preparing them it was necessary to make certain assumptions as to rates of interest and time of construction. The rate of interest taken on the money invested is 6 per cent, on the theory that the enterprise would be financed one-half by 5-per cent bonds and one-half by 7-per cent stock, both bringing par in the market. The rates received on balances placed on "time" loans and "call" loans are taken respectively as 6 and 4 per cent, both figures being high.



Diagrams Showing Wrong and Right Methods for Figuring Interest during Construction

The first diagram simply assumes that all money contracted in excess of actual expenditures is either not paid in or is loaned at 6 per cent, thus imposing no burden on the company. The whole time of construction being taken at six years, which includes one year each for the preliminary and development periods, construction of each item—main line, terminals, branches, equipment, etc.—is assumed to begin at such a time as to effect its completion at the end of the sixth year. The heavy dash line is the summation of the expenditures for these items, exclusive of interest, and the heavy solid line adds the interest by the usual method, ignoring interest on interest.

The Proper Method

In the second diagram account is first taken of the irregularity of expenditures. The heavy dash line sums the actual expenditures as before; the heavy solid curve above it adds the interest, and includes interest on interest, as is proper. The stepped diagram above this curve indicates deductions that can be made from the total-expenditures curve for interest collected by the company. After the preliminary period it is assumed that at the beginning of each year enough money must be obtained to cover all expenditures for the year, with a margin of safety of from $12,000,000 the first year down to $9,000,000 finally as working capital when the road is completed. The upper line of each rectangle indicates the total amount of money raised to date. All money between these horizontal lines and the total-expenditures curve is "call" money, on which the company will receive 4 per cent. The shaded rectangles indicate this accumulated interest paid back to the company. At the end this amounts to $9,651,400. All contracted money above these rectangles is either not paid in or is placed on "time" loans, in either case imposing no burden on the company.

Summing up, the interest on construction by the usual method is $35,171,546. By the correct method it is $62,973,000 minus $9,651,400 or $53,321,600. Hence the difference or shortage is $18,150,054.

It may be said, however, that interest charges during construction should be credited with net earnings from operation during the development period. In practice this credit would probably be largely negligible because of excessive cost of operation with untrained forces under new and untried conditions; but for the sake of conservatism it may be assumed that at the end of the final period of construction the road would have the same net operating revenue as existed in the fiscal year 1913, viz., $13,935,552, thus making the average for the educational period one-half of this amount, or $6,967,776. Therefore the underestimate or shortage in net interest charges during construction is $11,182,278. The only place in which provision is made for this shortage is in the contingency fund.

Working Capital

In the prosecution of its business the company has the following funds continuously engaged for unremunerative purposes: (1) Stock on hand, (2) amounts due from others and (3) cash on hand for (a) payments due others and (b) emergencies and fluctuating demands. During the past few years the cash due from others has fluctuated from $2,850,000 to $5,100,000, averaging about $4,000,000. There was due to others varying sums which the company should be in readiness to pay promptly regardless of corresponding sums due from others. Assuming that cash on hand for this purpose should equal 25 per cent of the amount due others, the sum required is $1,000,000. As an excess for emergencies a further fund would seem proper of, say, $1,500,000. Stock on hand for the last twelve years has averaged about $2,500,000, and this amount seems necessary for the normal operation and maintenance of the property. Adding these four items together, the figure of $9,000,000 for working capital and stores is obtained.

This method was adopted with the object of eliminating cash and stores in excess of the normal operating requirements of the company.

Vancouver Terminal

TERMINAL improvements of the Canadian Pacific Railway at Vancouver, B. C., are rapidly nearing completion. The tracks at this point are along Burrard Inlet, at the foot of Granville Street. The general scheme, which was described in the Engineering Record of July 20, 1912, page 67, embraces a passenger station and office building, an additional pier 200 x 490 ft. and a steel viaduct over the trainshed and freight yard to afford access to the pier, with an incline between tracks and bulkhead to reach the lower level.

Barrott, Blackader & Webster, of Montreal, are the architects for the work. Westinghouse, Church, Kerr & Company, of Montreal and New York, are the engineers for the complete design, construction and equipment of the terminal, working in co-operation with the officials of the Canadian Pacific Railway.

Snow-Covered Peaks in the Vicinity of Mount Natazhat

Canada-Alaska Boundary Survey

Technical and Non-Technical Features of the Joint Work of the United States and Canadian Governments

By J. D. CRAIG
D. L. S.; Assoc. M. Can. Soc. C. E.; In Charge for Canadian Commissioner of Field Work on the One Hundred and Forty-First Meridian

SINCE the famous London Tribunal of 1903 and the later treaty of 1906 the work of delimiting the boundary between Alaska and Canada has been carried on unremittingly by the Governments of the two countries, and the field work is now practically complete. Under the direction of the commissioners, O. H. Tittmann, superintendent of the Coast and Geodetic Survey, for the United States, and Dr. W. F. King, Dominion astronomer, for Canada, the huge task has progressed by leaps and bounds and will be completed well within the estimated time.

Few people realize the immense length of Canada's western boundary, and fewer still know of the difficulties and dangers of work in the rugged regions traversed by the line. From Cape Muzon, at the southern extremity of Dall Island, the line crosses Dixon Entrance and follows up the Portland Canal, thence following, more or less approximately, the many sinuosities of the very rugged coast of Southeastern Alaska, until it reaches Mt. St. Elias, from the western shoulder of which, to the Arctic Ocean, the 141st meridian of west longitude forms the boundary between the Yukon and Alaska. The distance along the line from Cape Muzon to Mt. St. Elias is 887 miles, of which 180 miles are across water, leaving 707 miles of actual land boundary through the rugged coast country. From Mt. St. Elias to the Arctic is 647 miles, making the total length of the boundary 1534 miles. By the treaties between Great Britain and the United States this line was to be "sufficiently marked" throughout its entire length, the various turning points, reference marks and monuments to be located geographically, and maps made showing in detail the topography of the country adjacent to the line.

RECONNOISSANCE MAPS

As a preliminary step to the settlement of the boundary question, reconnoissance maps had been made in 1893, 1894 and 1895, mostly by the Canadians, who used the comparatively little known phototopographic method, of the coast region from the Portland Canal to Mt. St. Elias. These maps were used at the London Tribunal of 1903 as a basis for the final adjustment of boundary differences, and on them were indicated the various mountains which now form the turning points of the line. [This phototopographic method was described in the Engineering Record of Sept. 25, 1909, page 355.]

The boundary divides itself naturally into two parts, the southeastern or "panhandle" strip extending from Cape Muzon to Mt. St. Elias, and the 141st meridian. With the exception of the strictly water boundary between Cape Muzon and the head of the Portland Canal, the southeastern portion is a zigzag line running from peak to peak as determined by the tribunal. Where the straight line between adjacent peaks crosses an important river valley, or any other prominent topographical feature, one or more monuments are set and a vista with "a twenty-foot clear sky-line" opened out through any existing timber. The 141st meridian is marked by a similar opening out of the vista, and by setting monuments about 3 miles apart all along the line.

MONUMENTS

Two classes of monuments are used in this work. At the more important or conspicuous points, a pyramidal monument of aluminum bronze about 5 ft. high and weighing about 300 lb. is set, while at the less important and more inaccessible points a small conical monument, also of bronze, about 2½ ft. high and weighing about 55 lb. is used. Both types are set in concrete, using about 200 lb. of cement to the monument, with the proper proportion of sand and broken rock to make a good concrete. The only exceptions to this were where the small monuments could be set by grouting their fluted legs into holes drilled in the solid rock.

All monuments and the various mountains constituting turning points on the line are now located geographically by triangulation. The southeastern part of the work is referred to the southeastern Alaska datum of the U. S. Coast and Geodetic Survey, and is "tied in" to the stations of this survey on the coast by nets of triangulation extending up the valleys of the various rivers used by the different parties to get from the coast to the line. The phototopographic camera was again used on this section of the work to supplement the information obtained by the earlier surveys already referred to.

ONE HUNDRED AND FORTY-FIRST MERIDIAN

The 141st meridian had been located temporarily at its crossing of the Yukon River in 1887 by the late William Ogilvie,

Fleet of Survey Launches on Upper Old Crow River

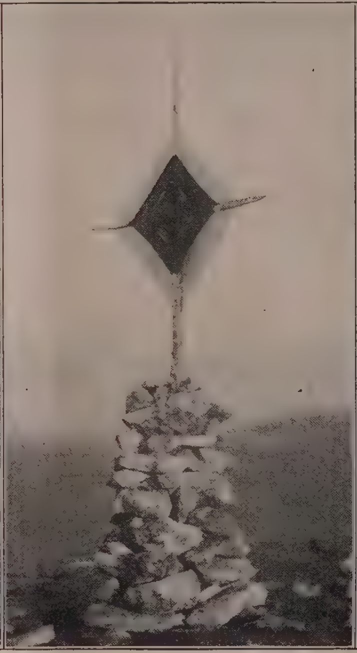
Transit and Heliograph at Main Projection Station

Dominion land surveyor, one of Canada's greatest pioneers, and was in 1907 relocated in accordance with the most modern astronomical methods by a series of joint observations by a Canadian and an American observer, with telegraphic connections with Vancouver, via Dawson, and with Seattle, via Eagle, Alaska. In spite of the fact that Mr. Ogilvie's line was located by what might be called field methods, and in the dead of an Arctic winter, it was found to be only 369.6 ft. west of the new line. From this point the meridian was projected during the seasons of 1907 and 1908 south to Mt. Natazhat, and during 1909, 1910, 1911 and 1912 north to the Arctic Ocean.

The line was projected north and south on the azimuth determined by the joint observers in 1907, by a joint American and Canadian party using a Berger 6¼-in. theodolite with a specially designed micrometer eye-piece, using heliotropes as fore and rear sights and for keeping up communication between these points and the main instrument party. This method of projecting a straight line had been used only once before to any extent, and a short description of it might, therefore, prove interesting.

Small Monument at Inaccessible Point

Large Monument of Aluminum Bronze



Target Signal and Cairn for Triangulation

Vista through Timber, Yukon and White Rivers

PROJECTING THE LINE

The work was handled by a main or instrument party and a fore and a rear heliotrope party. These latter parties used ordinary heliotropes, but for convenience of communication the main party had a heliograph of the latest British military pattern with a pivoted mirror actuated by a telegraph key. The rear party was kept on the "back sight." Their duty was to keep their light shining steadily on the main station, having their helio set accurately over their own station.

The main party, having set up their theodolite carefully at the last station determined, put the fore party approximately on line by ordinary instrumental methods on a suitable ridge ahead, directing their movements by helio. The fore party then established two points, 1 or 2 yd. apart, one on either side of the approximate line, and having carefully marked them by drill holes in the rock or by some other permanent method, set their helio over one of the points and showed their light to the main party. The main party then read carefully, by means of the micrometer eye-piece, the angle between the rear helio and the forward point slightly off the straight line, the Canadian and American observers making alternate sets of observations until their means agreed within certain prescribed limits. Then the fore party was directed to move their helio to the other point, and the angle to it was similarly measured. Meanwhile the fore party had carefully measured the distance between the points with a tape and this was next transmitted to the main party, who by a simple calculation, knowing the distance between the points and the angle to each point, were able to compute the exact position of the true line with reference to either point, the two observers checking each other's work by making separate computations and using slightly different methods. This position was transmitted to the fore party, who carefully measured off the distance and marked the true line permanently, this measurement being checked by the main party when they occupied this station.

The usual distance between main stations on the line was from 10 to 12 miles, although in some cases excellent work was done at more than 20 miles. In addition to their uses in connection with the projection, the helios proved very useful in getting information from the fore party, who naturally were first over the ground, as to trails, camping places, fords, and other points of much consideration in the field, thus saving the later parties much time and inconvenience.

The line marked on the ground was the mean line, that is, its position is midway between the lines of the Canadian and the American observer respectively. A net of triangulation was also run along the meridian, serving as a control for the plane-table topography, as a check on the azimuth of the line, and as a means of determining the latitude of each monument. This work was done under American supervision, while the Canadians opened up the vista, measured the line by stadia methods and set the monuments. According to the treaty each Government bears the costs of its own parties in the field, except that the actual cost of the monuments and of putting them in place is to be divided equally between the two.

TRANSPORTATION DIFFICULTIES

As might be expected, the chief difficulties met with were practical rather than technical. No particular difficulties were encountered as to methods of survey, although atmospheric conditions peculiar to the different regions made special methods necessary in some instances. The almost continuous cloudy weather of southeastern Alaska delayed the work there greatly, and on the Arctic slope the rawness of the winds coming in off the ocean made instrument work uncomfortable, to say the least, particularly when the station, as was often the case, was at an altitude of 5000 or 6000 ft.

The question of transportation, however, proved to be the big problem of the survey. On the "panhandle" part of the work canoes were used on the various rivers to get up to the vicinity of the line. On some of the larger rivers this was comparatively easy—in fact in one or two cases it was possible to use power launches almost as far as the line. On the smaller streams, however, it meant many days "bucking" swift water, and then usually many more days back-packing either through the thick underbrush prevalent on the lower levels along the coast, or, further inland, over treacherous glaciers and steep rocky mountain sides. In the region between Mts. St. Elias and Natazhat particularly, back-packing was the general rule, assisted in some cases by sleds moved by dog or man power, or both. From White River to the Arctic Ocean it was found possible to use horses over the entire line, bases of supplies having first been established on the main rivers by steamboat. Launches, two of which were specially designed and built for freighting, were used on Old Crow River and on the shallow waters of other northern streams. In the White River district much freight was also distributed by horse sleds during the winter months.

FOOD AND FUEL

Considerable doubt was expressed by those supposedly familiar with the northern country as to whether it would be possible to find there any feed for horses. As a matter of fact, it seemed as if the farther north the survey worked, the better the feed became, and in the summer of 1912, fifty or sixty horses lived for practically a month on what they could "rustle," and without oats, right on the Arctic Coast, and worked hard all the time. In connection with the horses in this part of the country, it might be noted that the natives, having no word in their language for "horse," called them the "big dogs," and while they were astounded at the loads they could carry, were much disappointed when they found they would not eat fish as their own dogs did. The native dogs at Rampart House also had their surprises. When the steamer carrying the joint party blew her whistle for a landing there in the spring of 1911, the two or three hundred dogs assembled there with the natives emitted one long howl, took to the hills back of the post, and were not seen again for several days.

Another question which caused much discussion was the fuel supply in that northern country. Old-time residents in the vicinity of Porcupine River declared that fuel for camp purposes was very scarce north of there, and that we would be forced to rely on oil fuel for a considerable period. Here again they were found to be in error, as we were able to find plenty of fuel in patches all along the line, although at times it was only small willow. At the coast itself, where there was absolutely nothing growing that could be burned, the whole country being tundra, we found an abundance of driftwood.

The launches built specially for the northern portion of the work were of the usual shallow-draft, stern-wheel type, and were 45 ft. long and of 9-ft. beam, fitted with 25-hp gasoline motors. They could handle a barge with from 6 to 10 tons of freight in splendid style. Where the current was very swift the launches were "lined" upstream by means of a power capstan attached to the motor, handling about 1500 ft. of steel cable. These two launches in 1911 and 1912 made a combined mileage of nearly 20,000 miles.

Quite an army of men has been kept employed by the survey for several years. Since 1904 from forty to seventy-five men have been used each year on the southeastern coast work, and since 1907 as many as ninety-five on the meridian. In 1911, on this latter portion of the work, in addition to two full-fledged river steamers engaged in freighting for the survey, there was a fleet of four launches and several poling boats. The overland transport consisted of about 195 horses. These horses, costing from $60 to $75 at point of purchase, were valuable animals by the time they were landed where they could be used, as it cost an average of from $100 to $125 per head to "take them in" and feed them on the way. They were usually brought back as far as the Lake Kluane district in the fall and wintered very successfully in the open, although many died one winter owing to exceptional conditions.

Great contrasts were found in the climatic conditions on the different parts of the work, stretching as it does from 55 to 70 deg. latitude. Along the southeastern coast the field working season extended over about 150 days, and of these in some years as few as 25 were found to be good working days, owing to the heavy rainfall and continuously cloudy weather. These conditions rendered phototopographic methods necessary on this section. In the Mt. St. Elias region winter conditions prevailed practically all summer, the working season was shortened to about 120 days, and owing perhaps not so much to the high latitude as to the elevation of the country heavy snowstorms and frosts were liable to be encountered at any time. The elevation of the lower plateau here is from 3500 to 6000 ft., while the peaks rank among the highest on the continent, St. Elias towering up 18,000 ft. and Logan to the northeast of St. Elias boasting almost 20,000 ft.

North of here, from Mt. Natazhat, in latitude 61 deg. 32 min., to the Arctic Ocean, weather conditions were better, although as the work progressed north the working season shortened, until north of Porcupine River it was only 100 days from the first navigation up the river in May until it was time to retreat rather than take the risk of being "frozen in." Deducting from these 100 days the fifteen required to get north by pack-train to the starting point and the twenty days required to return to Rampart House in the fall, an idea is given of how short the season actually was.

The highest and most difficult climbs on the work were probably made this last season, when one of the Canadian topographical parties occupied Mt. Natazhat, El. 13,000, and a joint American and Canadian party succeeded in getting to within about 2000 ft. of the summit of Mt. St. Elias. This party would probably have been successful in reaching the summit had not a four days' snow-storm depleted their supplies to such an extent that they were forced to retreat to their base, 40 miles away over the glaciers. These were special climbs, however, and the general average of climbs in this region was not as great as this, although there are many triangulation and topographic stations above El. 10,000. The actual climbing was not always the most hazardous or arduous part of the work, however. One party last season, backpacking on the glaciers, were roped together every day for more than a month, and many were the falls and slips into crevasses, any one of which might easily have proved fatal.

The swift rivers of the coast also did their share in making the work dangerous. Full of snags, sweepers, bad riffles and short turns, boating on them either up stream or down is always risky. In spite of the dangerous character of the work, however, and of the great number of men employed for such a period, the loss of life has been remarkably small. One man perished when a snow cornice on which he was standing broke off and dropped him a sheer 1500 ft. Two others were last season swept into the Pacific by a rock and timber slide, and three men have died, though not in the field, from illness brought on by hardships and overexertion in the field.

Survey Pack Train Crossing a Glacial Summit

Supplies Stored on Animal-Proof "Cache"

RESULTS

As the final result of this expenditure of time, money and energy, what have we?

First of all, the boundary line between the two countries is delimited and marked for all time, as far as can be done by human agency, and so as to be prominently visible for many years to come. The vista opened out and the monuments set insure this. In all, 269 monuments have been set. On Portland Canal and points adjacent are some sixty pyramidal concrete reference marks. Each monument or mark is located accurately and may be used as the initial point, or as a tie or check on future land or engineering surveys. On the meridian the monuments are numbered consecutively from the Arctic southward, so that anyone encountering one of them can locate himself immediately by referring to the map.

Then we have, or will shortly have, the maps. The topography along the meridian and for a distance of 2 miles each side of it will be shown on a series of maps, each embracing fifteen minutes of latitude and published on a scale of 1/65,000, with 100-ft. contours. The topography of the "panhandle" will be shown on "degree sheets" embracing one degree of latitude by one of longitude on a scale of 1/250,000, with 250-ft. contours. These latter maps will show the topography from the coast to beyond the line. The area mapped along the meridian is about 2600 sq. miles and that on the southeastern coast about 25,000 sq. miles, including the area mapped on the reconnoissance work already referred to, making a total of 27,600 sq. miles mapped during the survey.

Chlorinator Controlled by Traveling Weight

Automatic Scale-Beam Device to Administer Chlorine Gas to Water and Sewage

A TRAVELING weight on a scale beam is the controlling factor in a new instrument effecting automatic treatment of water supplies or sewage with free chlorine in the gaseous state. In making the action of the instrument dependent upon the loss of weight of the gas instead of its pressure, temperature or density, the designers acted upon the belief that the latter properties are subject to wide variations in practice. The device is in use at several water supplies—at Brooklyn, N. Y., Auburn, N. Y., Toronto, Ont., and Walden, N. Y.—and one machine is being tested in sewage treatment at the West New Brighton experiment station, Staten Island, N. Y.

The principle of the mechanism in its original form may be described as follows: Commercial chlorine stored in the liquid state in a steel flask containing about 100 lb. is suspended on a hook from a sensitive scale beam, mounted on hardened steel knife-edges. The counterbalancing weight on the beam may be fed forward either at a constant rate or in proportion to the rate of pumping. The beam communicates through a simple system of levers with a controlling valve connected by hard rubber tubing to the suspended cylinder. Any change in equilibrium of the system, due to the weight being set forward along the beam, causes the valve to open or close automatically to the proper size of orifice, which allows the exact weight of gas to escape continuously from the cylinder, keeping the scale beam in balance.

Application

If the flow of water or sewage is subject to fluctuation, the corresponding variation in the rate of speed is controlled from the pumping engine, the rate being in proportion to the number of strokes per minute and the number of pumps in operation. The device may also be readily connected with a Venturi meter, or it may be regulated from a float in case weir measurement is used.

Interruption in the flow of the gas due to the changing of cylinders is obviated by means of a special flask which is filled in place from cylinders containing 2000 lb. of liquid chlorine. In fact, it is intended, for sewage installations, that the machine be connected directly with these large cylinders, reducing the cost of both chlorine and labor.

This early type of the instrument has been developed by duplicating its parts in one unit, simplifying the changing of cylinders. Two scale beams are mounted together, from each of which a storage flask is suspended, one being held in reserve while the other is in operation. When the first becomes exhausted, the second is automatically thrown into action. The empty flask may be removed and replaced at the convenience of the man in charge of the apparatus.

The designers state that one machine will treat water supplies varying from 1,000,000 to 50,000,000 gal. daily. A miniature chlorinator has been made, which will treat quantities as low as 50,000 gal. per day. The additional amount of gas needed for sewage treatment will, of course, depend upon the character of the sewage. The designers state that the weight of chlorine used is about one-ninth the weight of hypochlorite of lime necessary for similar purposes. This economy is credited not only to the more accurate regulation but to the greater penetration of the chlorine in the gaseous form.

The chlorinator was designed by the Jackson-Leavitt Engineering Company, of New York City.

Comparisons of Systems of Flood Control

Sixth and Last Paper in This Series – Summary of Reports by Engineering Commissions on Flood Control and Lessons to Be Learned

By H. A. PETTERSON

Civil and Hydraulic Engineer, San Francisco

CHARLES ELLET, JR., is probably the first engineer in the United States who publicly advocated the construction of storage reservoirs for the improvement of the Mississippi and Ohio Rivers. His first paper appeared in 1849, but in 1853 a book by him was published giving his plans more in detail. The views expressed in the book were originally presented in a report by Mr. Ellet to the War Department under an Act of Congress.

Mr. Ellet urged the necessity of surveys to obtain the data required to decide the engineering questions involved. A paper entitled "Practical Views on the Proposed Improvement of the Ohio River," by W. Milnor Roberts, published in the "Journal" of the Franklin Institute 1857-58, opposes the application of the reservoir plan originated by Mr. Ellet as impracticable. It also states that the physical conditions are not favorable for finding suitable storage.

Another civil engineer, Elwood Morris, in a paper published in the "Journal" of the Franklin Institute 1857, reviews the "Practical Views" of Mr. Roberts, disagrees with them, and expresses agreement with the reservoir proposition of Mr. Ellet. Mr. Morris was fully satisfied in his own mind, from personal familiarity with the Ohio River, that accurate surveys would disclose adequate reservoir sites and demonstrate the practicability of the reservoir plan. He says: "No discussion will obviate the necessity of a suitable survey."

Congress was nearly persuaded of the reasonableness of Mr. Ellet's plan and was about to appropriate funds for the prosecution of suitable surveys on the Ohio watershed, but the strong personality of Mr. Roberts, who appeared before Congress, and his strongly expressed practical views, changed the minds of the wavering Solons, and the appropriation for the surveys was never made. Nor have the suitable surveys been made since that time.

Other engineers and engineering commissions have made reports on the improvement of the Ohio and of the Mississippi, but the surveys needed to sensibly report on the practicability of storage reservoirs were not made. The writer has frequently seen references to the exhaustive investigations by the Engineering Board of 1874, appointed to investigate and report a permanent plan for the reclamation of the alluvial basin of the Mississippi River subject to inundation. That part of their report devoted to reservoirs is so brief that it will be quoted outright.

Reservoirs

"This plan consists in arresting by reservoirs that part of the sudden drainage from the valleys of the tributaries which, if allowed to escape freely, would combine to cause floods in the lower channels. When the rainy season has passed, the gates of the artificial dams would be opened, and the extreme low stages, so injurious to navigation, would thus be prevented. In theory, this system is very attractive; but, in practice, it promises no relief to the lowlands of the Mississippi River, simply because there are no available sites for reservoirs sufficiently large to produce the desired effect.

The floods of Red River are so peculiarly disastrous on the Mississippi below its mouth that the secretary of the commission was instructed to visit the lake region near Shreveport, to ascertain whether an artificial increase in their capacity sufficient to materially reduce the flood level of the Mississippi is practicable. His report shows that such work must submerge large areas of land now under cultivation and be too costly for serious consideration. (The report of the secretary contains personal opinions based on a trip over the lower rivers in a boat, also opinions of several engineers living in the South. No surveys were made.) The question of absolute practicability could only be decided by a series of extensions and elaborate surveys, for which neither funds nor time were available, nor in the opinion of this commission are they needed. Here, as elsewhere in the valleys, this plan, as an efficient means of restraining the floods of the Mississippi, is in every sense of the word chimerical."

Recent Investigations

Former chief hydrographer of the U. S. Geological Survey, M. O. Leighton, revived the interest in storage reservoirs in a paper submitted to the Inland Waterways Commission and appearing in the 1908 report of that commission (see Engineering Record March 7, 1908, page 277). Mr. Leighton was able to command respectful attention because of the data presented by him. He knew the runoff from various parts of the watershed where previously it had been estimated, or rather, guessed at. He was also able to point out a great many reservoir sites located from the topographic maps over portions of the watershed. The increased knowledge obtained by him showed storage reservoirs to be more practicable than had heretofore been assumed.

PITTSBURGH FLOOD COMMISSION

The exhaustive investigations of the Pittsburgh Flood Commission (see Engineering Record, Nov. 11, 1911, page 560; March 30, 1912, page 337, and April 27, 1912, page 450) on the watersheds of the Monongahela and the Allegheny tend to confirm the pioneer reconnaissances of Mr. Ellet and Mr. Leighton. This commission found an excess of storage possibilities, rather than a lack, on these watersheds.

The report of Alvord & Burdick, consulting engineers for Columbus, Ohio (see Engineering Record Sept. 27, 1913, page 343), found that the maximum flood flow of the Scioto and Olentangy Rivers at Columbus was 140,000 sec.-ft. for the 1913 flood. They investigated ten projects, considering channel improvements, by-passes, levees, and combinations of these with each other and with reservoirs. Of six projects, each with a channel capacity of 200,000 sec.-ft., the project in combination with reservoirs was considerably cheaper than any other combination. Of the four projects with a channel capacity of 150,000 sec.-ft. the projects including reservoirs as a part of the improvement were somewhat more expensive. The engineers decided that inasmuch as the reservoirs also protect certain districts above and below Columbus, a combination project may be more advantageous when considered broadly and should be adopted in case financial co-operation between Columbus and other communities can be secured.

The plans of John W. Hill, consulting engineer for flood protection for the cities of Hamilton and Middletown, Ohio, and the County of Butler (see Engineering Record Nov. 29, 1913, page 599), embrace widening, deepening and straightening of the channel of the Miami River, and the construction of levees. The cost of the work for the County of Butler, including the protection of Hamilton and Middletown, is estimated at $12,250,000. These plans are purely local and the benefits derived from the proposed works would also be entirely local.

RELIEF FOR DAYTON

The plans of the Morgan Engineering Company for flood prevention at Dayton, which is also on the Miami River, show a broader scope and clearer vision. Their preliminary report (see Engineering Record March 28, 1914, page 356) indicates that a system of reservoirs, which would completely prevent floods in the entire Miami Valley, would cost about $12,000,000. The engineers find that due to the alternate widening and narrowing of the valleys of the Miami, Mad and Stillwater Rivers, they are peculiarly adapted to the construction of reservoirs. All of the more practicable sites over the watershed have been investigated, and six have been found to fully meet the requirements. These reservoirs would prevent floods along the Miami through the County of Butler as well, and remove the necessity of expending $12,250,000 by the people of that county, as proposed by Mr. Hill's report.

Wherever investigations of the possibilities of storage reservoirs in the Ohio Basin have been accompanied by suitable surveys, these investigations have found that such reservoir sites were available and that flood control by regulation of the runoff was entirely feasible, either by reservoirs alone, or in combination with methods for increasing the channel capacity.

What are some of the lessons to be learned from the reports of these engineering commissions? First, that generalizations in the matter of flood control are apt to be dangerous and misleading. Messrs. Ellet and Morris pleaded for surveys to substantiate their statements that reservoir sites existed on the watershed of the Ohio Basin. Mr. Roberts, by reasoning based upon generalizations, persuaded Congress that the surveys were unnecessary, and Congress, as well as humanity in general, seems to be destructive rather than constructive in its thought and action.

LESSONS FROM THE REPORTS

After the terrible floods of the spring of 1913, the catastrophes at Dayton and Columbus were used as strong arguments that reservoir control for the Ohio Valley was chimerical. Prominent engineering journals and prominent engineers cited the lack of reservoir sites on the northern tributaries of the Ohio as conclusive proof that flood control by storage was out of the question. The engineers, who studied the flood problem for Dayton and the Upper Miami Valley, entered upon the investigation of the possibilities of storage reservoirs simply to make their report complete. At the time of undertaking the survey, the engineers did not consider reservoir construction feasible for this locality. A search for reservoir sites was made largely because of the policy of investigating every possible means for improvement, before becoming committed to any particular one. It has been a distinct surprise to them to find how perfect may be the control of floods by means of a system of reservoirs.

Second, these flood studies on the Ohio are forcing thoughtful engineers to one conclusion at least. They all are beginning to see that what is needed is not more discussions and arguments of self-satisfied, pompous engineers with their broad generalizations, but impartial investigations, surveys and engineering studies. They are beginning to realize that benefits derived from flood protection by a system of bypasses, channel enlargements, levees, etc., are purely local. In spite of previous opinions, these engineers are being forced to the conclusion that flood control by storage reservoirs is practicable for many rivers, and may be feasible even for the entire Mississippi Basin, or, at least, in combination with other methods.

THE MISSISSIPPI BASIN

They see that a comprehensive study of the entire Mississippi Basin is essential to the working out of the best plan. The problem of flood prevention and flood protection for the Mississippi Basin cannot be investigated by itself. Inseparably connected with it are the problems of navigation and river regulation, irrigation in much of the land tributary to the Missouri, power development on all of the rivers, land reclamation, not only in the alluvial lands of the Lower Mississippi, but in the swamp lands of Minnesota, Wisconsin, Iowa, Illinois and Missouri, and the protection of numerous cities and towns subject to inundation.

Thoughtful engineers see clearly that the attempt to solve each of these problems by itself will lead to unnecessary duplication of work done and a vast increase in the cost. The idea of each little hamlet attempting to construct its own flood prevention works independent of the other cities and towns and farming regions in the same valley is evidently absurd. The interrelation of the problem on the Ohio Basin and the alluvial lands of the Lower Mississippi is not so self-evident, but, nevertheless, the relationship exists.

The unanimity of opinion among engineers on certain phases of the flood control problem is well expressed by Gen. W. H. Bixby, formerly Chief of Engineers, U. S. A. He states:

"All engineers, both foreign and American, with great unanimity have apparently agreed that theoretically the storage reservoir method is the only proper and logical method up to its limits; but the engineering fraternity has been greatly divided, and still is to-day, on the question of the practicability of the reservoir method, when considered from a combined legal and financial point of view."

The differences of opinion caused by questions of relative cost can only be settled by the proper surveys and engineering studies. The legal difficulties are not insurmountable. The co-operation of different States with the U. S. Reclamation Service in the matter of large irrigation projects is an illustration of the tendency toward co-operation in those matters where large benefits can only be gained through such co-operation.

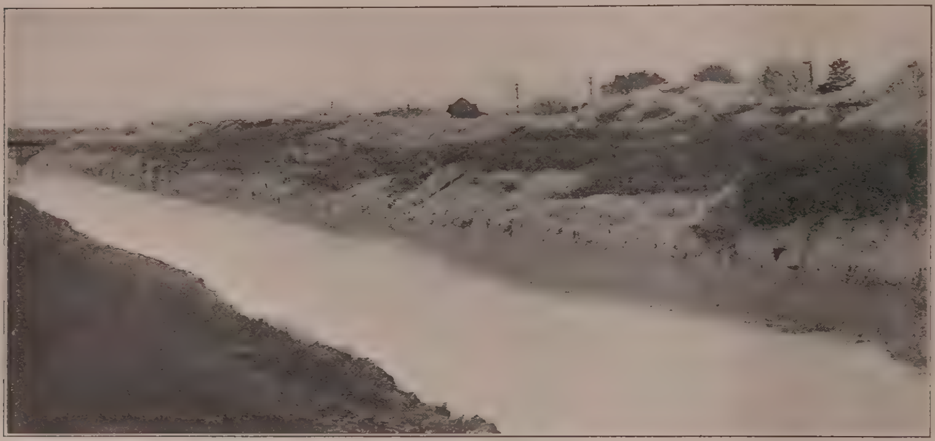
ENGINEERING DATA NEEDED

The great need of the present time is not to decide upon methods, but to decide to obtain all the engineering data and information so essential to a really intelligent final decision. In other words, get action by Congress and the Federal Government so that an engineering commission, with the proper authority and with sufficient resources, can make the comprehensive surveys and investigations necessary. No decisions as to final plans should be made until such a commission has completed its investigations.

The great need at the present time is not for half-baked investigations by engineering societies without the funds or authority to make their findings worth while, but the great need is for engineers and others interested to co-operate; to initiate, and carry out a campaign of education, which will make clear to the Federal Government the necessity for surveys and comprehensive engineering investigations before money is appropriated for construction.

At least the great majority of engineers want this question decided right. Money spent for surveys is well expended. The engineering and scientific data obtained will amply repay the cost of such work, even if the plans proposed are not executed. It would be a colossal blunder to carry out plans for the expenditure of hundreds of millions of dollars without knowing positively that such plans are the best that can be made, all things considered. Opposition to suitable surveys savors either of dishonesty or of stupidity and bigotry.

THE SUSPENSION BRIDGE across Bulkly Canyon in British Columbia, described in the Engineering Record of April 4, page 386, was built by George Cradock & Company, Limited, of Wakefield, England.



Sliding Banks on the North Shore Channel Before Paving of Slopes

Handling Canal Bank Slides in Chicago

Abstract of Report to Sanitary District of Chicago on Investigation and Conclusions Following an Inspection Trip to Panama

CONFIRMATION of methods now in use for handling slides of canal banks of the Sanitary District of Chicago has been made by E. J. Kelly, assistant chief engineer, Philip Harrington, resident engineer, and three trustees who recently returned from a visit to the Panama Canal and from various bank protection operations at Memphis, New Orleans, Houston and Galveston. Most of the time was spent at Panama.

Comparison of the slide problem at Culebra with that which has vexed the Sanitary District trustees and engineers in the construction of the North Shore Channel and the Calumet-Sag Channel reveals, according to the report from which the following notes are taken, many features of surprising similarity—this, too, in spite of the fact that at Culebra the geologic formation is the result of periods of volcanic disturbance, while the Sanitary Distric work lies in a region of comparative uniformity. The solid limestone formation which underlies almost the entire vicinity of Chicago varies in depth from outcroppings to about 100 to 150 ft. below the surface. This rock is a great bedded formation of Niagara limestone varying in thickness from 250 to 400 ft. It is grayish in color with the stratifications usually almost horizontal, and of variable thicknesses. Prior to the glacial period this rock comprised the ground surface of the region and the fact that many species of fossils, especially of marine animals, are found would seem to confirm the theory that almost the entire vicinity of Chicago was at one time covered with water.

GEOLOGICAL FORMATION

Overlying the Niagara limestone is a layer of varying thickness composed of unconsolidated material termed "drift." This drift not only overlies the rock formations in the vicinity here discussed, but, in fact, extends over a large portion of northern United States and Canada. This drift was deposited directly or indirectly through the agency of glaciers, and while stratified deposits of sands, gravels, and clays are of frequent occurrence, on the whole the drift is unassorted. It consists generally of a bluish clay in which is embedded rock material of all shapes and sizes. This stony material ranges in size from fine gravel to boulders of great size, but for the most part these pieces of rock are less than 1 ft. in diameter, with boulders 2 to 3 ft. in diameter of rather frequent occurrence. The arrangement of this drift is most heterogeneous, fine and coarse, clay and stones being intimately mixed. The usual formation encountered in the Sag valley, where the Calumet-Sag Channel is now being constructed, is a shallow layer, not exceeding 5 ft. of a clay having a light yellowish or buff tint, just below the top soil, below which is found the blue clay which forms the body of the drift. This blue clay sometimes becomes very dense and is excavated with difficulty. Below this is often encountered a formation of a hard brown clay, sometimes containing gravel and small boulders partially cemented. This material is extremely difficult of excavation, and often necessitates resorting to blasting. Occasionally a water-bearing layer of blue clay containing a large percentage of sand and silt and varying in thickness from 1 to 5 ft. is encountered. The silty clay, locally termed "bull-liver," is very unstable and when exposed has a tendency to flow. Its supporting power is, of course, very small, and this formation has constituted one source of trouble in maintaining the canal banks in a state of equilibrium.

Another source of difficulty has been found where seams of clay resembling shale have been encountered in excavating work. The clay tends to disintegrate and crumble upon exposure to the atmosphere, an action which results in the great weight of the bank being unsupported. Consequently the bank has a tendency to move into the channel. In the swampy regions, of which there is a large area along the route of the Calumet-Sag Channel, extensive peat beds are found. This peat formation sometimes occurs at a depth of 10 to 20 ft. below the ground surface, although usually it constitutes the top soil. When relieved of the moisture which it has absorbed, it is very light in weight and incapable of supporting a high bank. As a result, considerable difficulty has been encountered in designing the canal slopes and disposing of the spoil to meet this condition.

KINDS OF SLIDES

Three types of sliding ground have been encountered as follows: (1) Structural breaks resulting from inability of a layer of drift to hold the weight of the overhead bank. (2) Normal or gravity slides. (3) Surface erosion.

The structural breaks are in many respects similar to those encountered at Culebra. They occur at points where a layer of shale upon exposure to the atmosphere disintegrates and crumbles. A crack or fissure then develops in the bank, sometimes at a distance of 200 to 300 ft. from the channel center line. The crack gradually widens and deepens as the bank moves slowly into the channel. Instead of a layer of shale, the prime cause may be a peat stratum, which is frequently encountered along the route of the Calumet-Sag Channel, or it may be a soft, silty or unstable clay which causes the failure of the bank. In any case, the effects and results are about the same as those found in the West Culebra slide.

The second type of slide, the normal or gravity slide, results from the movement of the overhead bank upon a slippery layer of clay or other material, the line of stratification of which is clearly defined. It is due almost entirely to an excavated slope steeper than the angle of repose of the particular formation then being excavated, and in many cases has been further aggravated by the superimposing on the berm of heavy spoil banks at a comparatively small distance from the slope. This type of slide, which has been quite common on the North Shore Channel as well as the Calumet-Sag Channel, is typified at Panama by the Cucaracha slide.

The third class of sliding material, that due to surface erosion, is found in many

Placing Pavements for Protection of the Calumet-Sag Channel Banks places on the North Shore Channel and the Calumet-Sag Channel, and is marked by a gradual sloughing of the surface of the slopes due to the weathering action of the elements. In addition to those elements which are met in Panama, such as rain and wave action, the action of frost is a contributing cause of slides of this character in our work. The freezing and thawing of the bank tends to further aggravate the sloughing of the surface of the slopes, so that the sowing of shallow rooted grasses and like vegetation is not in all cases a sufficient preventive means.

The fault zone slides, of which there are several at Panama, have not as yet been encountered on the Calumet-Sag Channel work and of course were unknown on the North Shore Channel where no rock excavation was done. However, a similar failure of the bank occurred on Section 5 of our Main Drainage Canal, which was due to a fault in the apparently sound natural limestone formation. This failure resulted in the collapse of the superimposed wall at this point and the projecting of the material into the cut.

Section of Completed Pavement on Bank of North Shore Channel

REMEDIAL MEASURES

The remedial measures which have been adopted by the Sanitary District for the first two classes of slides have been practically those which have been used by the United States engineers at Culebra. The position which the Sanitary District engineers have always taken in dealing with this type of slides is this: Where slides occur due to the failure of an underlying stratum of material to hold up the unbalanced pressure automatically applied by the cutting of the channel, or where the bank created by the same operation shows movement upon an underlying stratum of a different material, the only remedy which can be advised is the flattening of the slopes until sufficient weight has been removed to establish a state of equilibrium; in other words, until the angle of repose for the material then moving has been attained. For this reason it has been maintained that waste or spoil banks should be placed at a considerable distance from the banks in all cases where preliminary borings show indications of formations of this character and the side slopes of the channel designed flat enough to prevent movement of the bank. The distance that the spoil bank should be placed from the channel and the angle of inclination of the side slopes are subjects of conjecture, and may be arrived at with any degree of accuracy only by one having long experience with similar work and with the particular class of material to be encountered. It is far from an exact computation. However, it may be generally said that the angle of inclination of a slope to prevent movement is in most cases steeper than the angle necessary to retard and stop the movement of a bank which has commenced to slide. For this reason it can readily be seen that it is far more economical to excavate the side slopes to the necessary inclination as the excavation is carried down to grade, than it is to allow the material to slide and excavate it afterward. Not only does the latter method tend to increase the total yardage in any cross-section, but it also involves other difficulties, such as extricating machinery, track, etc., with the accompanying loss and expense, and at completion finds a canal with an irregular, ragged appearing bank, which invites the rain and weather to commence a process of gradual erosion, and washing down of the surface.

The original excavation through the Culebra Cut was all made in conformity with the original design for the side slopes of three vertical to two horizontal, or somewhat steeper than 45 degrees. While these slopes are still standing in some places, in others movement is still noticeable with the slopes reduced by slides into the channel, and by the removal of material which has been excavated from the slopes in an effort to prevent further movement, to one vertical on five horizontal. The weight which has caused this movement has been that of the bank itself, because the spoil from the channel has been transported away from the canal and used in the reclamation of otherwise valueless land. From the above information it appears now that it would, perhaps, have been more economical to have excavated these slopes to a flatter inclination than that designed as the cut was carried down to grade. The Calumet-Sag Channel, having a cut of about 40 ft., was designed with slopes in earth of one vertical on two horizontal, with the spoil banks removed from 50 to 100 ft. from the top of the slope. In some cases this has proven an ample margin of safety, while in others slides have occurred at points where the material is soft and of unstable character. These conditions have been recognized and much of the later work, awarded by contract, has called for one vertical on three horizontal slope, with the spoil banks removed 400 ft. from the top of the slope. Moreover, in one case, where the material is exceptionally soft, the contractor has been ordered to place no spoil on the berms, but to transport it approximately ½ mile to a specially provided dump. From the above it can be seen that the Sanitary District policy differs from that at Panama in that it is deemed more economical to prevent the material sliding than it is to let it slide and dig it out, as is the policy of the engineers at Culebra.

VEGETATION ON SLOPES

To prevent slides due to surface erosion the only precaution which must be observed at Panama is to see that the natural growth of vegetation on the slopes is not impeded. One season's growth in this tropical country will cover the slope with an almost impenetrable blanket of grasses and shrubs, the roots of which are so interwoven as to form a continuous mattress reinforcement a few inches below the surface of the bank. On the Sanitary District canals where this planting was tried the problem is not so simple, due principally to the variance in climatic conditions encountered. While the rains in the vicinity of Chicago do not compare in intensity with those in the tropics, a disturbing factor which more than offsets this is met in the frost which annually penetrates the soil to a depth sometimes as great as 3 ft. This annual freezing and thawing tends to keep the upper stratum of the bank in a disturbed condition, and particularly susceptible to the heavy spring rains which follow. For this reason it can be readily seen that the sowing of shallow rooted grasses and the growing of vegetation (which is much less dense than in the tropics) are practically of no avail.

The remedy which has been found most successful and efficient has been to rip-rap

Sliding Banks on the Calumet-Sag Channel during Construction the side slopes with large-sized rubble in a layer 8 to 10 in. thick placed upon a 12-in. layer of crushed stone or gravel. The crushed stone or gravel forms a cushion between the rubble and natural bank and at the same time provides a watercourse for the surface water which would otherwise flow down the slope. It also tends to prevent the frost making any great headway into the slopes, and thus obviates the results of thawing. In some cases it has been found advantageous to drive a pile and timber foundation with batter piles in front to act as a brace for this rip-rap slope pavement, this foundation serving a twofold purpose. It not only acts as a support for the rip-rap, but it also tends to prevent further movement of the banks due to the overhead weight. It has been tried on the North Shore Channel, and, so far, has proven entirely successful. However, where rip-rap can be placed before the water has been turned into the channel, it is better and more economical to carry the slope paving to a solid natural foundation, such as rock or very hard earth. This latter method is now being employed on practically the entire length of the Calumet-Sag Channel, the rock necessary for the rubble being excavated from the canal.

Rubble and Concrete Slabs

At Memphis and neighboring points along the Mississippi river, rubble and concrete slabs are both used as a paving for the upper river banks. These are placed directly upon the prepared slope, but the United States engineers agreed that this could not be done in districts where frost action was to be reckoned with. Instead of the timber and pile foundation for the rip rap, the mattress revetment is used as a support for the upper bank pavement, while serving at the same time the main purpose for its construction; i. e., to prevent caving of the soft alluvial soil which forms the bank between high and low water. This condition, of course, has not been encountered as yet in any of our work, and hence we cannot recommend the use of this type of slope protection. Concrete slope paving is used along the Mississippi River because of the cheapness and accessibility of gravel as compared with rubble. Compared on a basis of durability, rubble is favored over concrete. However, the hydraulic grader which is extensively used in preparing the river slopes is thought to possess some features of interest, and it might, perhaps, be advisable to try this method of trimming slopes on some of the Sanitary District work. It is only a question of suitability of the material to this kind of excavation, and the low cost and excellent work which an excavator of this kind is capable of warrant its trial where a fair chance of success is assured.

On Sanitary District work it is not practicable to acquire a 10-mile right-of-way as is the case on the Panama Canal, so that it is necessary to place the excavated material on the berms of the canal. For this reason it follows that means must be taken, in many cases, to prevent movement of the bank, instead of letting the material slide and afterward excavating it.

EARTH STICKING TO DUMP CARS can be prevented by covering the bottoms of the cars with sheet zinc. A large contractor in New York City found this out after trying, without success, galvanized iron and sheet iron.

Terminal Freight Congestion

Consolidation of Trucking Interests and Operation of Trucks on Schedule Proposed as the Solution of the Problem

EXTENSION of railroad methods beyond the terminals and into the streets by means of consolidation of trucking interests and operation of trucks on schedule is the remedy for terminal freight congestion proposed by Fred A. Hortter, car accountant of the Boston & Maine Railroad. These arguments are taken from his presentation of the subject before the Electric Vehicle Association of America at its meeting of April 24.

Observation of the terminal-yard teaming in the Boston & Maine yards in Boston showed that in one day 10,264 horse-drawn vehicles handled freight to the outbound freight house. In that week the total outward movement of freight was 22,416 tons. This means that the average horse-vehicle load was only 0.36 ton.

Use of railroad freight cars for storage purposes is apparently on the increase, as the average detention for 1911, 1912 and 1913 was respectively 1.58, 1.63 and 1.66 days per car. Expressed in terms of cars, the railroads of New England alone have been called upon to increase their equipment by 800 cars within three years at a cost of $1,000,000 merely because of the inefficient system under which the freight is handled beyond the railroad's terminals.

Increased Car Detention

This increased freight-car detention time not only makes a proportionate decrease in railroad working equipment, but seriously affects terminal yard facilities, the expansion of which is definitely limited by city real-estate values and the conditions of the surrounding properties. In this quandary the railroads must seek the cooperation of the business world in order that they may work out the problem of securing the best transportation possible from the shipper to the consignee not only by the railroad but by street; and teaming through the streets has not progressed materially during the period in which the railroads have practically revolutionized the entire freight-handling system.

It has been evident in past years that a multitude of small railroads not operated as a system cannot produce the quality of transportation that is demanded in this great country in which we live. The result has been to amalgamate these small lines into powerful systems of railroads under one management. However, when we consider the trucking industry in our various cities we find a multitude of teaming concerns that are operating independently without any attempt at co-operation or a consolidation along the lines of greater economy or increased efficiency.

It is commonly said that in our large cities the teamsters are not making any money. When we consider the lost motion and waste which characterize their efforts it is not surprising that they are not growing rich. These various trucking concerns perform under contract about 60 per cent of the street haulage of freight in our larger cities. Most of the business houses prefer to hire this service because they themselves have been unable to solve the problem of handling it for themselves largely because of failure to apply scientific study to its intricate propositions.

For years you gentlemen of the motor-vehicle industry have been endeavoring to introduce modern machinery to replace the horse in this service and thereby produce a better quality of street transportation. You have not gone far enough. You have not endeavored to change the method. You have merely tried to improve the tools and so far you have done well; but improvement in the means without change in methods will go but a little way in the ultimate solving of the terminal freight problems. Some slight advantage may be obtained, but so long as the efficiency of the apparatus is limited by the system under which it operates the problem is no nearer solution than ever.

Consolidation of Trucking

The remedy lies in the co-ordination of the railroad and highway movement of merchandise and a collaboration of the railroads and the teaming interests. There should be co-operation between the railroads and a consolidation of the trucking interests. The principal advantage of this plan to the railroads lies in a train-schedule system of operation and a marked reduction in the detention of freight on railroad premises.

A powerful and efficient trucking organization of this nature should not only effect an enormous saving over present cost, but also render greatly improved service through the employment of scientific and efficient methods of operation and a truck-dispatching system worked out along the same lines as are the train-dispatching and car-distribution systems of our railroads. This would prevent the use of a 5-ton truck for carrying a few hundred pounds of freight one or two miles across the city, by arranging to have that truck move via a definite schedule to its destination, picking up en route sufficient other parcels of freight to utilize to the fullest extent the carrying capacity of the vehicle.

Furthermore an organization of this kind could probably establish central clearing stations at convenient points in the business districts to which light-capacity vehicles could be run from nearby warehouses and from which consolidated loads could be moved in high-capacity trucks to the railroad and steamship terminals, bringing back on their return similar heavy loads of inward freight for redistribution from the central station. Thus we could secure substantially an extension of the railroad operating method beyond railroad terminals.

Warehouse to warehouse delivery is successfully carried on in Europe, and from the fact that more than 60 per cent of our city freight haulage in Boston, New York and Chicago is done under contract with truckmen it is evident that the business world in our large cities would welcome an improvement along these lines.

THE BOISE & ARROWROCK Railroad, which is operated by the U. S. Reclamation Service in connection with the Arrowrock dam in Idaho, and is the only standard-gage railway ever built and operated by the Government, earned $9,721.31 net in 1913 on $44,516 gross revenues. The railway, which is about 20 miles long, carried 20,641 passengers and handled 499,933 ton-miles of freight. The total net earnings of the line from the moving of its first train in September, 1911, until Dec. 31, 1913, were $25,383.63.

Present Status of Wisconsin Water Powers

Abstract of Paper Read before Engineering Society of Milwaukee on Jan. 14 by Daniel W. Mead, of the University of Wisconsin

WISCONSIN is seventeenth among the States in its water power resources. The developed water power of Wisconsin amounts to about 225,000 hp., based, however, on the turbines installed instead of the actual power of the stream at the points of development. The average minimum theoretical horse-power which can be developed for the six months of minimum flow on Wisconsin streams is approximately 350,000 continuous horse-powers, and the average minimum theoretical horse-power for the highest six months of the average year, approximately 650,000.

A well-designed turbine at its point of maximum efficiency, properly installed, will develop from 80 to 85 per cent of the theoretical power of water. Under operating conditions it is impossible, however, to maintain a load which will realize such a percentage of the theoretical power, and under average conditions of operation, even with the best designed plants, it is improbable that more than 70 per cent of the theoretical power can be delivered at the turbine shaft. The net horse-power, therefore, which can be delivered at the turbine shaft, from Wisconsin streams, will be an average minimum of 245,000 continuous horse-powers, for the six months of minimum flow and an average minimum of 455,000 for the flow of the highest six months of the year.

Conservation of Water Power

A fair estimate of the average amount of coal used in the generation of power is 3 lb. of coal per horse-power-hour. On this basis the amount of coal saved by the utilization of the minimum undeveloped water power of Wisconsin would be 3,430,000 tons per annum; and if it were feasible to utilize water power to the additional extent of the minimum power of Wisconsin streams for the maximum six months' flow, a further saving would be effected of 1,470,000 tons of coal per annum, or a total of practically 5,000,000 tons.

In recent years there has been a popular delusion in the mind of the public that as undeveloped water power is energy going to waste, those who may develop and utilize such power will garner untold wealth and will pocket the returns from a natural resource which should justly belong to the people of the state or of the nation. If the energy of water could be turned into power without expense or hazard, there would be a legitimate reason for such an assumption. Such a saving can, however, never result from the development of any natural resource. There is no line of development of natural resources so universally safe that its development must not be regarded as largely speculative and subject to many risks and contingencies.

As a broad general proposition, it may be conservatively estimated that the development of the potential water powers of Wisconsin would cost at least $100,000,000 without including the cost of transmission systems or the cost of investment in collateral industries necessary for their utilization. If the entire power could be sold at a price which would realize net, the value of the entire saving in coal as above estimated, the rate of earnings would be but 10 per cent on the investment. Taking into account the hazard of hydraulic construction and the possibilities of failures due to the market, and the contingencies of operation and maintenance for the risk involved such a return is inadequate. There are probably few citizens in the state who would be attracted by such an investment, if they knew or appreciated the risks, even though they were absolutely sure that the average returns of such an investment would be 10 per cent. on the average investment: although it is equally true that if the investor could be assured an absolute return of 10 per cent on his investment from water powers, every power in the state would be rapidly developed. On the other hand, what enormous profits would be realized by the public through a judicious investment of $100,000,000 in water powers and probably $200,000,000 more in collateral industries and improvements!

The Hazards of Water Power Developments

Unfortunately, perhaps, the development of a water power is not a simple method of surely capitalizing the waste energy of our streams and pocketing the returns. In the first place, the hazards involved both in the construction of such properties and in the contingencies of their operation and maintenance are very great. With the advent of electrical transmission coupled with the popular conception that water powers were always excessively profitable, and that by means of such developments the waste energy of water could be advantageously turned into dividends, investors eagerly sought water power investment. The results have not always been satisfactory. The first large Niagara hydraulic development operated for twenty years without a dividend. The great developments at McCall's Ferry on the Susquehanna River, at Messina on the St. Lawrence River, and at the Sault Ste. Marie are examples of financial catastrophes and failures, the list of which could be greatly increased if further illustrations were desirable. Foreclosures and sales of water power properties have been very common. In one case within the State, the investors in the bonds of a water power company realized less than 5 per cent of their par value. In other cases plants have been abandoned and dismantled. It is, of course, apparent that such projects were ill-advised and should never have been undertaken, or, if attempted, undertaken on a more conservative basis.

It is true that plans for large and important structures are rarely devised that do not require more or less modifications during construction. Unless this fact is duly appreciated by the designer, and liberally allowed for in the estimate of cost, such estimates have always been found more or less inadequate to complete the structure. In the superstructure of one of the large buildings of Chicago, designed by one of the best architects of that city, and which was completed without any serious mishaps, the cost of extras increased the original contract price almost 25 per cent, or a matter of $700,000 on a $3,000,000 investment.

In a recent water power development [Mississippi River Power Company, at Keokuk, Iowa] which was under advisement for a number of years, and which was perhaps more thoroughly considered and carefully planned, both as to its design and methods of construction to be pursued than any other development of late years, the cost of the finished structure exceeded the estimate by 33 per cent. The estimate of cost was about $21,000,000; the actual cost, $28,000,000. In another case where less care was used on account of the belief in the fallacy of the water power "gold mine," the original estimated cost was $800,000, and the actual cost of the complete development about $2,500,000.

The unexpected extra costs of such developments due to unforeseen delays are often serious. The interest on bonds must be met semi-annually or annually from their date of issue; hence, interest during construction is an important item in the cost of development of any industry, and an item which is particularly uncertain in water power development.

It is of course obvious that a project which may be very attractive on a basis of an investment of $800,000 is likely to be a serious failure on the basis of an investment of $2,500,000; and even a project which seems attractive on the basis of a $21,000,000 investment may be seriously handicapped by an expense of $28,000,000.

Contingencies of Maintenance

Even after a plan is once constructed the contingencies are not removed. Within the last few years a flood in one of the rivers of the state caused a loss of at least $300,000 to a single development. This loss resulted from an extraordinary condition which could hardly have been foreseen. In this case, the gates of the plant were so clogged by a rush of logs that the flood waters, unable to pass the dam, cut their way entirely around the structure. In another case a dam was seriously injured by a flood produced by the destruction of another dam built by a different engineer. The dam destroyed possessed sufficient strength and capacity for all contingencies of normal flow that were liable to occur; yet the unexpected destruction of another structure afterwards built above it caused an extraordinary condition that resulted in a loss of perhaps $150,000.

Losses through defective designs are numerous. In a western plant, just about to be started, the whole foundation was washed out from under the dam, leaving the structure suspended from the rock walls of the narrow canyon [Elwha River Dam, Engineering Record, March 28, 1914, page 372]. This loss was undoubtedly due to the defective design, and cost the company at least $125,000 and a year's delay in beginning operation. Numerous instances could be recited where either fundamental defects or extraordinary conditions have destroyed or seriously injured dams and water power plants and caused serious losses to their owners.

Water Powers as Monopolies

The popular conception of water power development is that such developments are usually carried out by men of great wealth combined in a so-called water power trust known as the "trust which will control all other trusts" and variously described by the writers of popular conservation and economic fiction. This water power trust or monopoly is largely mythical. This octopus is not a resident of Wisconsin. There are about two hundred and twenty-seven investors interested in the Southern Wisconsin

Power Company at Kilbourn, Wis., more than fifty of whom live in Wisconsin, and about three hundred and fifty in the Wisconsin River Power Company at Prairie du Sac, Wis., and about two hundred and twenty-five in the Peninsular Power Company, whose plant is on the Menominee River between Wisconsin and Michigan near Iron Mountain, Mich.

THE PENINSULAR POWER COMPANY

The Peninsular Power Company has been publicly referred to as owned by the U. S. Steel Corporation, because the superintendent of the Oliver Iron Mining Company is interested in the project. As a matter of fact, the great majority of stockholders in that company are residents of Wisconsin, and have absolutely no interest in the U. S. Steel or Oliver Iron Mining companies.

Most of the magazines and other papers of the state and the nation, and many public officials, have consistently misrepresented the facts in the case, and have given an entirely erroneous idea of the control of water power properties, and such false ideas are largely responsible for the passage of the unjust law of 1913.

Water powers seldom occupy the enviable position of monopolies with which they are popularly credited. There are places in the United States where, on account of the long distance transportation, fuel is very expensive and water generated power from nearby sources may partake somewhat of the character of a monopoly. This is not true in Wisconsin where the competition between water generated power and power generated from other sources of potential energy is almost always close, and in many cases water power is found to be more expensive than such other sources. Even when water power can be furnished at low rates, it can seldom be utilized in manufacturing industries where exhaust steam can be utilized in the manufacturing process or for heating purposes.

COST OF WATER POWER DEVELOPMENT

A water power to be economically developed must practically be developed to certain proportions regardless of its market. Powers on large rivers can seldom be developed and operated successfully in a small way. On a given river it is almost as expensive to develop a small amount of power as to develop the stream to its capacity. The same dam with the same appurtenances is necessary, whatever the development. The same operating force will usually be required whether the plant is fully or partially loaded, and whether the development is partial or complete. If the power is transmitted, the same towers required for 5,000 kw. will carry 10,000 kw. successfully. The completed development will involve a larger power house, a few more turbines, generators, and equipment, a little larger transmission wire, and these are usually the only extra expenses involved. Hence, on large streams the project must be sufficiently large to pay, and can be made to pay only when an adequate load is secured. The investment in these plants is so great that they can never be built except for a market already developed, at least for their principal load, unless industries are developed in connection with them. Both fixed charges and operating costs begin at once when the plant is constructed, and interest starts with construction. A market must be obtained at once on completion in order to meet fixed expenses, or the plant must soon go into bankruptcy. In almost every case these plants enter competition in a market already supplied with power, and therefore are under certain disadvantages when the power is placed on the market.

Small water powers of a few hundred horse-power may sometimes be developed so economically and operated so cheaply that they can compete in places where the cost of steam power is high, but never where steam costs are low unless the plant is built or combined with industries actually using power.

The measure of the actual value of power in any community is the cost of developing such power by the means ordinarily used, or which would ordinarily be used for the development of power under the conditions, and in the quantities used or to be used, in the particular location.

In fixing the rate at which power must be sold there are two natural limitations which must be considered: The higher limit is the price "that the traffic will bear"; in other words, the highest price which can be established which will not discourage the use of power, or be so high that large users of power will continue to generate power themselves, or will be induced to undertake its generation rather than contract for its purchase. The lower limit is the actual cost of the power to the water power company, which cost must include fixed charges and operating expenses based on the contingencies of the venture. Between these two there is frequently a wide range in values.

THE RATE

Before the installation of the water power plant is begun, the higher price is the true value; but the moment an installation is completed, in order to secure immediate custom it becomes practically necessary to reduce the price for commercial reasons in order to induce power users to become customers.

The basis established in the law of 1911, apparently fixes the value of the water power at the higher rate, and so high that from a commercial standpoint such rate cannot obtain, as there would be no inducement whatever for individuals using any considerable quantity of power to become customers, for the price they would pay would be the actual cost of such power as generated by their own plant, and there would be no inducement offered to become customers of the water power company. The higher price is, therefore, a commercial impossibility, and the lower rate is evidently inequitable, for there is no valid reason why a private company or the public who have risked nothing should have the full benefit of any commercial venture. The public, including all consumers of power generated by such a plant, will from commercial necessity receive a portion of the benefit from the use of such power, as a foregoing conclusion from the commercial conditions that follow its development. Rarely, if ever, even without rate control, can a water power company secure the higher return for its output. A water power company must, as a rule, supply power to a market, partially, at least, already supplied with power from some other source. Investments in power generating machinery of some kind have already been made. Fixed charges have already been incurred, and the water power company finds, therefore, that it must, in order to introduce its product, sell power below the station cost of producing the same by means of steam plants, and not on the basis of fixed charges plus operating expenses of the steam plant, which has been the true measure of the actual value of power to the date of introduction of power from the new source.

DIFFICULTIES IN THE SALE OF WATER POWER

If power generated by steam is costing on an average 1½ cents per kilowatt hour, and power can be generated by water at an average of 0.75 cent per kilowatt hour, it would appear on the face of these figures that water power must indeed be a "gold mine." A consideration of the facts will show that even on this basis, water power may prove unprofitable. In the first place it must be remembered that not all water power plants can produce power even under the best conditions of load at the cost stated. In the second place, few plants can produce power at such figures without the sale of a large proportion of their possible output on the most advantageous basis of loading. In the third place, a water power company can never secure a price for its output equivalent to the actual cost of power at the point where it markets its product, except when the development is undertaken by a company actually utilizing power in its business, and with a business great enough to practically utilize the entire output of the hydraulic development. For example, consider a community of 30,000 or 40,000 in the interior of the state. A well planned steam electric plant working under the conditions which ordinarily obtain in such communities can develop power at its switchboard for about 1.6 cents per kilowatt hour; of this amount approximately 0.5 cent per kilowatt hour is fixed charge, and 1.1 cents per kilowatt hour are station costs.

SALE TO STEAM ELECTRIC COMPANIES

If a hydro-electric company desires to sell its output to the steam electric company it will immediately be argued that the fixed charges are already incurred, and it will then be shown that the station charges are essentially as noted above, and even a portion of these costs cannot always be eliminated. There is no immediate economy to the steam electric company in the purchase of water power generated current (although this may not be true if the future be taken into account), unless it can purchase it at less than its station cost; consequently, to effect a sale, the water power must be sold at from 0.8 to 1 cent per kilowatt hour delivered at the customer's switchboard. The higher price might probably be regarded as scarcely attractive to the steam electric company, and the lower price would seldom be attractive to the water power company, and in many cases would involve a direct loss; and in almost every case, a direct loss would be entailed unless the total amount of current sold to all customers constitutes a large proportion of the capacity of the plant. If a direct combination can be effected between the water power company and the steam electric company, the steam plant may be utilized as an auxiliary to the water power, and the whole value of the output utilized by the combined interests. This kind of a combination is usually the only way in which a larger net profit can be obtained from a water power development. The best results can be obtained only by combination with an industry or market already developed, in which the power can be utilized at its true market value.

Siphonic Spillway for a Hydroelectric Plant

Design and Tests of Wasteway of Large Flume Connected with Tennessee Power Company's Second Ocoee River Development

By WILLIAM P. CREAGER
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INCLUDED in the novel engineering features introduced by The J. G. White Engineering Corporation in the second hydroelectric development of the Tennessee Power Company on the Ocoee River, Tennessee, is a spillway consisting of a battery of eight siphons used in connection with the flume. The development was described by the writer in the Engineering Record of April 18, page 454.

The flume which carries the water to the head of the penstock line is a wooden structure 4½ miles long, designed to carry a maximum discharge of 1200 sec.-ft. This discharge is fixed by simple overflow waste weirs in the side of the flume at its upper end. The height of this spillway can be adjusted to limit the flume discharge to any desired amount. The main flume discharges into a forebay formed by the construction of a concrete dam across a small ravine about 300 ft. above the intake to the penstocks. An extension flume connects the forebay with the penstock intake. The forebay dam is about 90 ft. long at the top. The forebay has an area of 10,000 sq. ft. at normal water surface.

SPILLWAY REQUIREMENTS

On account of the great length of the main flume and the small storage capacity of the forebay, it is necessary to waste the flume discharge when the turbine gates are suddenly closed. The problem presented many difficult features. It was found that the ideal spillway for this purpose should possess the following characteristics:

1. It should accommodate the required discharge with close regulation of the water surface in the forebay. The high-water surface in the forebay is limited by the elevation of the sides of the flume. The difference in level between high and low water surface represents lost head, which for 1200 sec.-ft. amounts to more than 100 brake-hp per foot. This difference in level would necessarily have to be added to the height of the flume extension, as this extension, of course, must be large enough to discharge 1200 sec.-ft. with low-water surface in the forebay.

2. It should be not only automatic, but quick acting. As 1200 sec.-ft. supplied to the forebay will raise the water surface at the rate of 1 ft. in about eight seconds, if the spillway should fail to take care of this discharge it would find an exit elsewhere with damaging results.

3. Its crest length should be limited to the length of the forebay dam. The lower end of the main flume and all of the flume extension rest on an earth bench excavated in the steep hillside. Consequently an attempt to provide a spillway in the side of the flume would result in excessive expenditures for taking care of the waste water to prevent erosion of the flume foundations.

SELECTING SPILLWAY TYPE

It was evident from the first that an ordinary overflow weir would not be advisable, as, with the limited crest length, the necessary large range of water-surface elevation in the forebay would result in the loss of too much head on the turbines and too great a height of the flume extension. Automatically operated sluice gates were considered too slow in operation and objectionable on account of the unreliability of the necessary electrical control. After considering various types of flashboards and other automatic devices, it was decided to adopt siphons as being most reliable and best suited to the existing conditions.

In a siphonic spillway the water flows through a closed conduit, producing a suction head that largely increases the velocity and consequently the discharge per unit area. Eight siphon units were installed at the plant in question within the concrete of the forebay dam. The section reproduced herewith indicates the general design of the units. The entrance area is located 5½ ft. below water surface, to insure freedom from floating trash. It is 3½ x 6 ft. in area and is protected by ⅜-in. screen bars spaced about 4 in. on centers. The entrance area gradually diminishes in the upper leg to 8 x 1 ft. at the top or throat, the larger dimension being horizontal. The lower leg is rectangular in cross-section and 8 sq. ft. throughout, but has a gradual change in shape to a point 12.8 ft. below the crest, whence its section is 4 x 2 ft. to the outlet. Four of the siphons operate under a head of 27.2 ft. and the other four under one of 19.2 ft. The concrete at the throat is protected by a casting which was also used as a form when placing the concrete. The 6 x 18-in. horizontal air inlets are provided for each siphon unit extending through the throat casting to the upstream face of the dam. These air inlets are protected by ½-in. round screen bars spaced 4½ in. on centers.

OPERATION OF THE SIPHONS

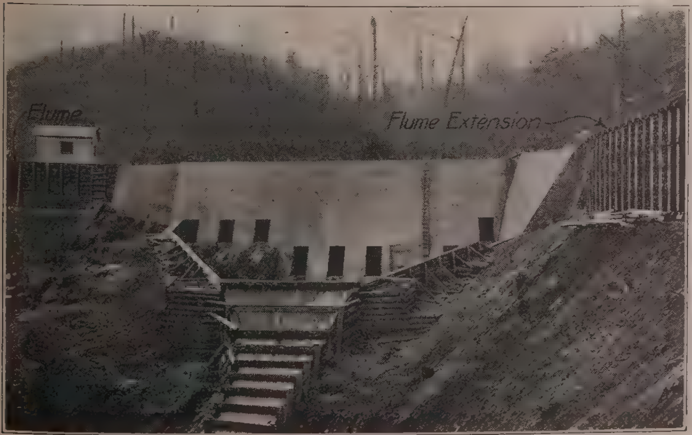
Under normal operation the water surface in the forebay stands at El. 1089.2 or at the elevation of the lip or crest of all siphons. When the discharge from the main flume exceeds the amount being used by the turbines the water surface in the forebay rises and spills over the crest of the siphons, striking the far side of the lower siphon legs. When the water surface reaches an elevation of about 1089.55, or slightly above the top of the air vents, the air thus confined in the top of the siphons, as well as that in the lower legs, is quickly ejected by the friction of the flowing water and the siphons prime. The suction thus produced increases the velocity to that corresponding to an effective head equal to the difference in elevation between the water surface in the forebay and the center line of the siphon outlet, less the head expended in friction within the siphon. As the discharge of the complete battery is greater than the maximum discharge of the flume, the water surface in the forebay begins to fall as soon as the siphons are primed. When the upper part of the air inlets becomes exposed the air drawn in by the suction reduces the efficiency of the siphons until the discharge is automatically reduced to that required for stationary water surface in the forebay. Should the amount of air drawn through the air inlets be of sufficient quantity, however, it will break the siphonic action. The water surface in the forebay will then rise again and the operation of priming will be repeated.

TESTING THE SIPHONS

Tests of the discharge capacity and the speed of priming these siphons were conducted by the writer last December after the plant had been put into commercial operation. They were made during the noon hour, as at that time the load demand was sufficiently small to allow this plant to be completely cut out from the general system without serious inconvenience.

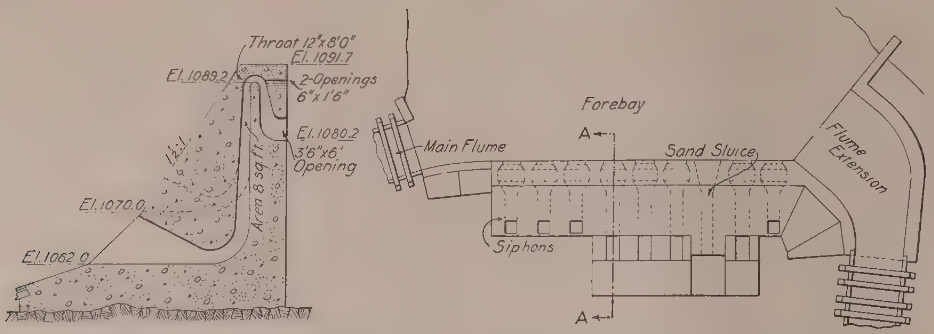
In the test for discharge capacity the preliminary arrangements consisted of: (1) Completely shutting off the load at the power house, (2) adjusting the flow in the main flume to 390 sec.-ft., (3) sealing the air vents on siphons 5 and 6, and (4) opening the air vents on the rest of the siphons.

After an interval of time the water surface in the forebay was drawn down to El.



Downstream Side of Spillway with Wooden Discharge Duct

Upstream View of Siphonic Spillway, Showing Screened Openings



Cross-Sectional Elevation and Plan of Siphonic Spillway at Ocoee River

1088.7, or 0.5 ft. below the crest of the siphons, and siphons 5 and 6 alone were flowing, both being completely primed. During the 7½ succeeding minutes it was observed that siphons 5 and 6 alone were passing water, that no water was passing the turbines, the main flume was discharging normally 390 sec.-ft. as previously determined by rating curve and checked by gagings and that the water surface in the forebay fell 0.3 ft. in the 7½ minutes, or from El. 1088.7 to El. 1088.4.

From these observations the conclusion was drawn that siphons 5 and 6 were discharging an amount of water equal to $W+X+Y+Z$, where W denotes constant quantity being discharged by main flume into forebay, or 390 sec.-ft.; X, quantity of stored water being drawn from forebay; Y, quantity of stored water being drawn from flume extension, and Z, quantity of stored water being drawn from main flume.

Knowing the surface area of the forebay to be 10,000 sq. ft. it is easily determined that

$$X = \frac{10{,}000 \times 0.3}{7.5 \times 60} = 6.7 \text{ sec.-ft.}$$

The quantity Y was drawn from a flume 14.2 ft. wide and 300 ft. long. As the length is comparatively short, the water surface was practically level, hence

$$Y = \frac{14.2 \times 300 \times 0.3}{7.5 \times 60} = 2.8 \text{ sec.-ft.}$$

The quantity Z was drawn from a flume 14.2 ft. wide and of sufficient length to extend beyond the effect of the draw-down at the forebay. If the draw-down had been infinitely slow the amount drawn from the storage would have been the volume between the back-water surfaces at the beginning and at the end of the draw-down. This volume was computed and found to amount to 18,000 cu. ft. Since, however, the draw-down occurred in a comparatively short period of time, it is improbable that all of this volume passed into the forebay, as it is evident that if the draw-down were quick enough a part of the total volume farthest away from the forebay would not have sufficient time to run off. A careful consideration of the problem indicates that the volume drawn from storage in the main flume amounted to about 10,500 cu. ft., whence

$$Z = \frac{10{,}500}{7.5 \times 60} = 23.3 \text{ sec.-ft.}$$

The average head acting on the siphon during the 7½ minutes of the test was 25.55 ft. Consequently

$$C = \frac{W+X+Y+Z}{2A\sqrt{2gH}} = \frac{390+6.7+2.8+23.3}{2 \times 8\sqrt{2 \times 32.16 \times 25.55}} = 0.65$$

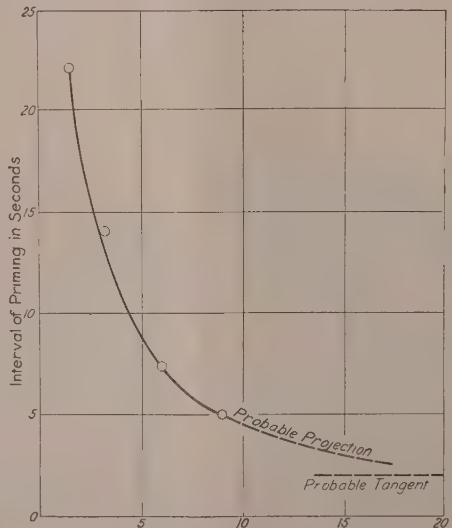
C being the coefficient of discharge. This represents the most probable value of C as determined from the experiments. The only uncertain element is the value of Z, or the discharge drawn from storage in the main flume. However, the error, if any, is small, as entire neglect of the value of Z merely reduces the coefficient from 0.65 to 0.62.

SPEED OF PRIMING

In the test for speed of priming an adjustment was made of the amount of water supplied by the main flume and used by the turbines so that the water surface in the forebay stood approximately at El. 1089.2, or at the crest of the siphons. In each case the water surface was slightly above this elevation so that it trickled over the crest of the siphons to a slight extent.

Upon adjustment of the water surface as above described and upon determining that no siphonic action existed in the siphons the order to throw off a predetermined load was given over the telephone to the operator in the power house. The effect of throwing off the load in the power house was observed in the forebay by a sudden rise of the water surface. The interval of time between the first indication of a rise of water surface and the complete priming of the first siphon unit was noted. This interval of time may be termed the "interval of priming." The result has been plotted on the accompanying diagram. In each test the interval of priming of the first and last siphon units differed only by the time required for the wave, incident to the rise of water surface, to travel across the forebay.

The interval of priming, in the sense here used, may be divided into two periods: (1) The time required for the water surface in the forebay to rise from the crest of the siphons to the top of the air vents, a distance of 0.25 ft., and (2) the time actually occupied in priming after the air vents were sealed. This may be termed the "speed of priming."



Curve Showing Interval of Priming

The first period varies inversely as the amount of load thrown off the turbines, while the second period, or speed of priming, is probably practically constant. It is unfortunate that the conditions under which this test was conducted did not permit of direct determination of the speed of priming. It is evident, however, that for a very quick rise of water surface, corresponding to very large load thrown off, the first period would be practically zero, and the interval of priming as recorded would equal the speed of priming. Some indication, therefore, of the value of the speed of priming can be ascertained from a projection of the curve on the diagram. The smallest interval of priming obtained in the tests was 5 sec., but it is indeed within reason to assume that if called upon the siphons will prime themselves in an interval of time not exceeding 2 sec. after the air vents are sealed.

The U. S. patents for this type of spillway are owned by G. F. Stickney and W. R. Davis, consulting engineers, of Albany, N. Y. The engineer and contractor for the work was The J. G. White Engineering Corporation, of New York City.

Alfred Noble

AT three score years and ten a useful life
Has run its course. And as we think of him
The sorrow and the flowing tears of friends
Are turned to joy that such a one as he
Has lived and wrought. Here was a man who led
In building up, a mind endowed to see
And think and do in all the larger things,
A Captain leading men on Nature's fields
To win in building monuments of peace.
This Engineer has shattered Nature's works
To make the world a better dwelling place
For all of us. His life was gentle and
No thought of self within him dwelt. He won,
Scarce knowing why, the plaudits of the world.
Upon his monument let it be writ:
He was an Engineer. He was a Man.

—W. L. Saunders in the "Compressed Air Magazine."

DRIVING PILES BELOW GRADE has been necessary in the reconstruction of the 1000-ft. Matawan Creek double-track trestle on the New York & Long Branch Railroad in New Jersey. The pile foundations were driven between the old bents about 12½ ft. apart and 30 ft. high while traffic was maintained on one track. The piles were 45 to 70 ft. and part of them were driven by a locomotive crane equipped with swinging leads having a telescopic section allowing the No. 2 Union steam hammer to follow the pile down 30 ft. below track grade. Part of them were driven with an ordinary driver with a 30-ft. follower. The pile bents were cut off, sills laid on them, caps secured under the existing stringers and the ten trestle posts inserted separately in position between them because clearance was not available for framing the trestle bents before erection. The work involved about 1100 piles and 750,000 ft. of long yellow-pine trestle timber. Rhodes & Manvel, Inc., of Elizabeth, N. J., are the contractors.

Book Reviews

The thirty-fifth annual report of the Massachusetts Board of Harbor and Land Commissioners, covering the period from Nov. 30, 1912, to Nov. 30, 1913, sets forth the status of harbor work, river improvements and the like at approximately 100 points throughout the State, records the history of the developments mentioned, gives contract prices for work let during the year and states the amount spent for the year and the total expenditures to date. There is also a list of permits granted during the year. Further tabulated information is given in four appendices. (Boston, Wright & Potter Printing Company.)

The proceedings of the sixth annual meeting of the Illinois Water Supply Association, held at the University of Illinois, March 9 to 11, have been published by the society. The volume contains 243 pages and 63 illustrations. In addition to the minutes of the meeting, list of members and reports of committees there are thirty-six technical papers dealing with all phases of the waterworks problem.

An interesting and valuable report which confines itself entirely to information—historical, statistical and otherwise—has been laid before Governor Glynn of New York by the New York State Commission to Investigate Port Conditions and Pier Extensions in New York Harbor. The title of the report, "Commerce of the Ports of the World," applies to a part only, such as statistics of imports, exports and tonnages for all ports. Of the 118 pages about forty are devoted to the port of New York, the history of its growth and development, expenditures to date on it, work projected for the near future, the laws and the designations and powers of officers and commissions controlling it, and much other useful information. There are also much data relative to other American ports on the seaboard and the Lakes. Not the least interesting feature of the report is a double page showing for comparison on a uniform scale maps of the ports of New York, Liverpool, London, Hamburg, Bremen, Amsterdam, Rotterdam and Antwerp. (Prepared by R. A. C. Smith, Chairman of the Commission and Commissioner of Docks and Ferries of the City of New York.)

MECHANICS FOR BUILDERS. PART II. By Edward L. Bates, Lecturer at the L. C. C. School of Building, Brixton, London, and Frederick Charlesworth, Whitworth Exhibitioner and Lecturer at the South-Western Polytechnic Institute, London. Board Cover, 5 x 7½ in.; 444 pages; 315 illustrations. New York, Longmans, Green & Company. $1 net.

(Reviewed by Melvin L. Enger, Assistant Professor of Theoretical and Applied Mechanics, University of Illinois.)

According to the preface the volume under review was designed to include "only those principles of applied mechanics which are essential to the student of building construction who desires to follow intelligently his craft and to understand how to design and carry out any work with which he may be entrusted."

The book begins with twenty-five pages on center of gravity, moment of inertia of an area and modulus of elasticity. This is followed by forty-four pages on beams, nine on columns and struts, seven on riveted and pin joints, eight on retaining walls, nineteen on masonry arches, twenty on testing materials and the physical properties of materials and ninety-one on reinforced concrete. At the end of the book are short tables of logarithms, anti-logarithms and trigonometric functions, and curves for finding square roots, cube roots and the area and the circumference of circles.

As the title indicates, the book is very elementary. A slight knowledge of trigonometry and of analytical geometry is presupposed. Proofs are not attempted of many of the formulæ used, but the formulæ are illustrated by the solution of typical problems, and a number of practice exercises are given at the end of each chapter. In some cases approximate formulæ are worked out, as for example in finding the deflection of beams it is assumed that the beam bends to the arc of a circle. The imperfection of this method is pointed out, and the student is then given the usual formulæ for the deflection of cantilever, simple and fixed beams for uniform and for concentrated loads.

The matter on reinforced concrete is based entirely on the regulations of the London County Council. Beams, T-beams, and columns with longitudinal and spiral reinforcement are taken up. Free use is made of graphical methods.

All things considered, the authors have succeeded in producing a book of value to the class of men for which it was designed.

Letters to the Editor

The War Against the Waves

SIR: Dr. Corthell's article on the "War Against the Waves," printed in your issue of April 11, page 408, comes as a very timely contribution to the investigations and discussions that are now being made by property owners along our Atlantic and Pacific Coast lines of the United States. Copies of it should be distributed to the Representatives in Congress, particularly those representing the States bordering along the coast, and also to the Governors of these various States. That which should impress them most in this article is the evidence of the co-operation of the foreign countries given to owners of shore-line property. The information and suggestions given in this interesting article by an engineer of such enviable reputation as Dr. Corthell should command attention and respect of all engineers and legislative bodies.

About five years ago I had occasion to study the conditions along the German coast, and during the month of January I was called upon by certain property owners at Sea Gate and Sea Bright to advise them in reference to the protection of the shore fronts in those localities. I find that the property owners are reluctant at this time to spend a great deal of money on any permanent type of construction, and I have advised them against the use of permanent construction until they have received co-operation from the local or Federal government.

Under date of Feb. 19, 1914, I also wrote one of our city officials regarding water fronts and harbor improvements as follows:

"The construction of groins and jetties at certain points along the water fronts of this greater city would protect the beaches and water-front properties for considerable distances. If these were constructed by the city, I have reason to believe that property owners in the vicinity of such improvements would be glad to construct permanent sea walls along the waterfront to preserve and protect the same for the future. Such damage as was caused at Sea Bright, Sea Gate and along the Long Island coast would probably have been less extensive, or entirely prevented, had the proper kind of jetties been constructed. Such improvement along our waterfront would result in far-reaching benefit to the entire city.

"My suggestion is that the rock and excavated material obtained from the new subways and other city work could be used for such improvements. At present the subway contractors are paid large sums for its disposal and then use it to fill in waste land previously bought by themselves. I believe that co-operation between the dock department, perhaps, and the property owners might result in a great benefit to the entire city. Permit me to call your attention, as an example, to the $20,000,000 improvement near Hunts Point being made by the Bronx Terminal Company, in which 10,000,000 cu. yd. of fill are being used to create one of the most valuable docking terminals in the entire country.

"The question arises as to whether the city is getting the full benefit out of the vast amount of contract work which is being undertaken by the city. While these contracts are not under the supervision of any one official, it might be advisable to provide for someone in the comptroller's office or in the efficiency bureau to study the various contracts let by the city with a view of securing the greatest results for the least amount of expenditure. This can only be done by a proper consideration of utilization of waste."

In the report I made to the property owners on Long Island and in New Jersey I have submitted to them certain types of sea walls and bulkheads of both temporary and permanent construction, but none of these would be as effective in protecting and building up coast lines as would be some forms of construction outlined in Dr. Corthell's article.

MAURICE DEUTSCH,
Consulting Engineer.

New York City.

Surface Waves in Pavements

SIR: Col. R. E. Crompton's theory as to the formation of waves in bituminous pavement surfaces (see Engineering Record for April 11) is interesting. Colonel Crompton, however, fails to state his case in full. When he says that deformation of road surfaces is caused by percussive rolling action of the wheel, "the wheels striking the ground at regular intervals," the writer would be inclined to disagree on the ground that no such behavior has been observed or indicated so far as he knows, at either very high or medium speeds. Moreover, he would incline to the theory that any pounding or "percussive" action would have less tendency to produce wave formation than a rolling action of the wheel and that the waves are actually caused by the rolling wheels accelerated by an insufficient or improper construction of the pavement surface. The writer does not concede that the aggregate moves "to and fro" but believes that it only moves in a direction opposite to that of the vehicle. Where the road surface is reasonably elastic and homogeneous in character and is passed over by a vehicle at a uniform speed, it does not require any stretch of imagination to picture the resulting wave if the tension on the pavement is high; and the waves must be reasonably uniform. The writer fails to see that "harmonic vibration" has anything whatever to do with wave formation, and does not believe that such vibration as, for instance, that of a bridge set in motion by tramping feet, is set up to an appreciable extent in road surfaces. They are too elastic.

This elasticity is due to the bituminous cementing material, and its distribution throughout the mass would certainly have an important bearing on wave formation. The fact that the waves observed by Colonel Crompton were regular might be accounted for by an uneven distribution of the cementing material throughout the mass, but this would not necessarily be the case. Most of the roads leading out of London are so narrow that cross-rolling is not a feasible operation, and the wearing surface can, therefore, hardly be as homogeneous and free from initial waves in its composition as where such rolling is employed. It seems as if the explanation of surface waving must lie in some such simple cause and in the rolling action of the wheel rather than its pounding, which is a vertical pressure tending to compact and harden the surface.

The writer inspected Colonel Crompton's three-axle roller while in London last summer, and believes that with a careful, intelligent rollerman good work can be done with it. A careless man, however, could spoil much good pavement, and it seems as if it would be difficult to get the average rollerman in this section of the United States to proceed with the necessary care. The roller would be costly to maintain, although not excessively so, and complicated in its operation.

Much the same effect that Colonel Crompton aims to secure is obtained in the Borough of Manhattan by doing the primary work with 5-ton rollers and following it by cross rolling with an 8 or 13-ton roller. The 5-ton rollers commonly used give a pressure of from 85 to 115 lb. on the forward roll and from 175 to 215 lb. on the after roll, and the 8-ton rollers give 130-lb. and 260-lb. pressures.

The pressure needed will vary with the character of the mixture, whether it be mushy, or open, or dense. An open mixture, for instance, should be treated with a light roller, affording a pressure between, say, 125 and 150 lb. per inch of run on the forward roll, followed by 200 to 250 lb. per inch. A heavier roller may push the material ahead, forming waves.

The pressures designed for the three-axle roller are no doubt the result of experience with the London road surface mixtures, which are quite different from our asphalt wearing surfaces. A pressure of 400 lb. per inch of run would, in American practice, be too much for the ordinary asphalt mixture. It would push ahead in a wave.

The matter of rolling is deserving of much more attention than seems ordinarily to be given it, and Colonel Crompton's effort to help the situation is to be commended.

DANIEL B. GOODSELL,
Assistant Engineer, Department of Public Works, Borough of Manhattan.
New York City.

"Civil Engineer" Defined

SIR: I have read with much interest your editorial article entitled "'Civil Engineer' Defined" in the issue of April 18. While I, of course, do not know the regulations of the engineering societies therein referred to, would not the outlined plan therein briefly alluded to result in a somewhat anomalous situation here in the United States? Would it not be possible for three members of the American Society of Civil Engineers, from motives that no one seems to have the right to question or review, to declare to the world that an applicant for membership in its body was not an engineer? Would it not be possible for such action to blast the reputation of such an applicant for all time? Is it wise or prudent for a leading American engineering publication to espouse a plan fraught with such grave possibilities?

For many reasons not necessary here to elaborate such a plan seems to the writer to be most arbitrary and unjust and one that, if adopted and carried out, would defeat the very objects for which, it is fair to presume, engineering societies are formed and conducted.

Utica, N. Y. W. G. STONE.

Conditions of Railway Employment

SIR: In an editorial of your issue of April 4 you ask the questions, What is wrong with the railroad engineering departments and why are so many good men leaving after a short term of service? The answer seems to be in the uncertainty of the work and the slow advancement, which, though reasonably sure, is inclined to make an ambitious man restless.

There is a question as to whether the subject should be discussed in a purely technical light or as a business proposition, or both. I am inclined to believe that in railroading the technical side constitutes about one-third of railway engineering and the business or operating the remainder. Railroading seems to be a kind of engineering which involves both strict engineering and business ability to such an extent that neither can be independent of the other, and to be a successful railroader a man must be not only a first-class engineer but also a thorough business man. The man who enters the service of a railroad and seeks to develop himself along these lines is the one who will stand the best chance of rapid advancement.

In most railroads in this country there are two engineering departments—maintenance of way and construction—sometimes under one chief, but many times under separate ones. The maintenance-of-way department represents the permanent organization, whereas the construction department, which deals with purely engineering problems, such as new work, additions and betterments, is at best only temporary, depending on the prosperity of the company. During retrenchment times little new work is being done, and the construction department suffers most, as the company cannot afford to carry "dead wood," and the only men reasonably sure of their jobs are the heads or chiefs of party. Many times the whole outfit is laid off, including the chief. With such conditions existing it is not a difficult task to understand why an ambitious engineer is inclined to regard railroading, from an engineering point of view, as a very uncertain proposition.

Even the maintenance-of-way department feels the effect of retrenchment times and many engineers are laid off. This is due to the fact that there are usually carried on the payroll of a division engineer for emergencies 20 or 25 per cent more men than are necessary for the ordinary run of engineering work. Extra rush work may occur two or three times a week and perhaps not as many times a month, yet the men are retained just the same. But when retrenchment times come these forces are cut to a minimum working basis.

Many a young engineer sees only the engineering side of railroading, and enters the service through the construction department. He has the false notion of becoming a great engineer of construction and a builder of railroads, but seems to forget that the day of great railroad building is past history and that the only construction work done to-day is improvement and extension.

Again, the opportunities are greater in the maintenance-of-way department, for from this department most of the executive chairs are filled. The man works himself up step by step to supervisor, division engineer, superintendent, and so on to general manager and higher. Of course, a great number get side-tracked as supervisors, but is that such a lowly and humble position? Engineers used to regard it as such, but with the class of men now holding these positions that prejudice is dying out. After all, the pay of supervisor compares quite favorably with that of the average engineer in other lines of work, and to the man who is really efficient there are higher positions awaiting him.

Taking a general view of the matter, I doubt whether the average successful engineer with any big engineering firm or corporation, such as structural iron or steel works, construction or electrical companies, are paid any better than men in similar positions with a railroad. When dealing with the subject of railroad engineering one must bear in mind the fact that the railroad is a big corporation and employs an army of men. It is true that the existing conditions tend to smother individuality, and that in order to shine one must be somewhat above the ordinary, but isn't that the same condition that exists in other lines of work, especially where a big firm or corporation is involved? And I feel sure that anybody who is conversant with railroad men and affairs will agree that the men holding high executive positions in a railroad company are, with few exceptions, survivors of the fittest. I do not mean to infer that I believe the pay of a man in the engineering department of a railroad is commensurate with his work—for such is not the case—but I do believe that it compares favorably with the pay of those employed by other large firms or corporations employing technical men.

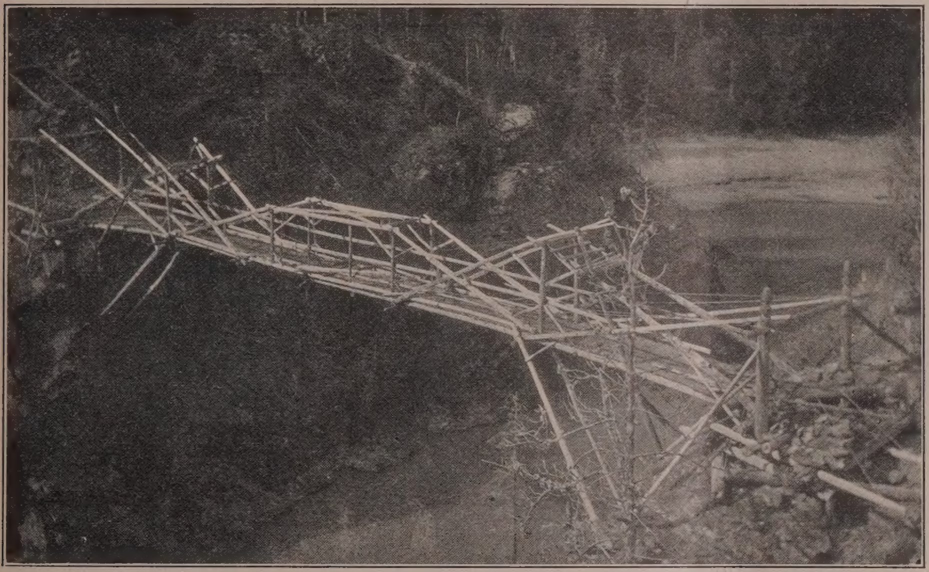
When asking the question why so many men abandon railroading for other engineering work, we do not stop to ask what percentage of these men who did not have the patience to wait for promotion in the railroad have succeeded in their new ventures, as compared with those who did remain with the railroad and have succeeded or failed.

A great evil in railroad work is the incessant driving of the man beneath. This extends through all executive offices of greater or lesser importance. Each man in turn drives the man beneath him, until it comes to the men who do the major part of the work in the field or office and in addition must stand all the abuse because they have no one else to whom to pass it along. Nevertheless, I dare say that railroad work claims more men who are in the work heart and soul for the love of it than any other branch of the engineering profession.

Titusville, Pa. W. C. O'NEILL, JR.

Engineering Training Based Wholly on Experience

SIR: In your issue of April 4 the article on page 386 entitled "Two Picturesque Bridges" neglects to mention certain features of the old Indian bridge which seem to me of interest. I am therefore sending the following as supplementary data.



Picturesque Indian Bridge across Canyon in Western Canada

As early as 1864 the Indians maintained a cantilever bridge at this crossing, and although their methods of construction may have been primitive their ideas of its value were very modern, for H. J. Cambie, the venerable locating engineer of the Canadian Pacific Railway, reports that in the year mentioned they charged him $8 per head to allow his crew of surveyors to cross. Mr. Cambie states that the bridge was purely a cantilever structure at that time, and that no wires such as have been used in patching up the present structure were available until Colonel Bulkeley stored some telegraph cable near the site in 1867. Since then cable has figured largely in the several attempts to bridge the canyon permanently.

Although the advent of the wire has greatly increased faith in these structures, no high degree of confidence was at first accorded the bridge crossed by Mr. Cambie. In fact, after it had been completed the tribal fathers would not declare it open for traffic until a number of squaws had been sent out upon it to see if it would stand up under a heavy load.

In the past twenty years the Indians have shown great perseverance in attempting to bridge the canyon permanently. A low-level footbridge built in 1892 lasted only two seasons. Then two whole years were spent by the united forces of two tribes in building a higher-level structure that would be strong enough to carry horses. This was completed in 1897, but in the following year there was an extremely hard winter followed by an early spring, and the unusual freshets swept away the new bridge.

In spite of these failures the Indians tried again, and this time built at a respectful distance above the waters of the narrow canyon. This last structure has weathered the storms and freshets of thirteen seasons and still stands, though tottering now, to mark the final success of an engineering training gained wholly by experience. The structure has a clear span from rock to rock of 146 ft., is 8 ft. wide and the stiffening truss at mid-span is 10 ft. high. Its floor is about 50 ft. above low-water level. Where two timbers lap they were fastened by a pin thrust through holes burned by red-hot coals, and where timbers butt together dovetailed joints were used, a wrapping of wire being put on wherever the builders found opportunity.

Victoria, B. C. K. T. ROBERTS.

The Fetish of Formulæ

SIR: In your issue of April 25, page 488, are two letters on "The Fetish of Formulæ," by E. E. Halmos and G. A. Heinrich. These letters are in response to one of mine under the same heading in your issue of Feb. 21, mine in turn being inspired by one from J. C. Prior, appearing in your issue of Jan. 10. Mr. Prior in his article shows that a six-rivet connection is weaker than the same connection with two rivets omitted. There is no question but that Mr. Prior's figures check by the usual method of solving eccentric joints. My letter gives another case of the same kind of paradox where a 6-ft. concrete wall was held to be weaker than a 4-ft. wall under the same conditions of loading.

Now both Mr. Halmos and Mr. Heinrich concern themselves with the pressure on the rock; when reduced to the same terms their answers agree, Mr. Halmos adding the weight of the concrete to obtain his result. The answers are, of course, correct, as a minute's calculation will readily show. To the pressure obtained by dividing the total load by the width of the footings is added the pressure obtained by dividing the bending moment by the section modulus of a unit section of the wall. This answer is correct, I say, if one assumes that there would be a bending moment. From my own observation of old masonry walls which were being demolished for higher structures, and which were built with a projection on one side only, I have abundant reasons for believing that in many cases the pressure on the soil must have been practically uniform. That is, in a high footing there was a spreading of the load.

However, this phase of the matter as well as the discussions of Messrs. Halmos and Heinrich has nothing to do with the case. I particularly stated in my article that the dissenting engineers found no fault with the pressure on the rock; in fact, they stated that they would not hesitate to permit a pressure of 50 tons. The question at issue is simply this: If a 6-ft. concrete caisson is not strong enough under given conditions of loading and allowable bearing on the concrete, can it be made strong enough by cutting off 2 ft.? Similarly, can you strengthen a six-rivet connection by knocking out two rivets? Let Messrs. Halmos and Heinrich answer those questions unequivocally.

It might not be amiss to add that discussions of this nature are interesting without the participants calling each other fools. Abuse and sarcasm are not good substitutes for logic. Honest argument is instructive for all concerned when carried on in a catholic spirit.

DAVID GUTMAN,
Chief Engineer, John G. Brown.
Philadelphia.

To Obviate the Opening Up of Pavements

SIR: I am taking the opportunity to accept your published invitation to discuss an editorial entitled "To Obviate the Opening Up of Pavements—A Suggestion" in your issue of April 18. While the criticism to be offered is not constructive, it may be helpful in inspiring comments from others acquainted with the problem which you bring up. On first reading your editorial one would be inclined to offer praise for such a courageous attack upon a well-known evil, but reflection has indicated several serious fallacies in the remedy proposed.

In the first place, handling the blocks will not be such a simple matter as you intimate. A simple problem involving two-armed levers will show that to swing a concrete block 14 ft. long—and many business streets will require slabs of greater length—from a flat car running on standard-gage tracks will require that the car weigh 19 tons. Introducing a factor of safety will bring this weight far above that of cars in use in electric-railway practice. This problem indicates a vital difference between the present question and the ease with which "40-ton blocks were placed in the unit subways of Kansas City."

Reflection also brings the thought that these 6-ft. blocks will form a pavement inferior in smoothness to those it is intended to supplant. The natural irregularities of the slabs will be enhanced by unevenness of the supporting shelves at curb and car-tracks. There will also be difficulty in securing a smooth effect at non-rectangular street intersections.

It appears, therefore, that your proposal, though valuable simply because it attracts attention to the subject, involves the following difficulties: Special cars of extra heavy construction must be designed to provide for the original placing of the blocks; although the original cost of the blocks, as you gave it—$2.70 per square yard—is plausible enough, the cost of placing them will be relatively high (there would be eighty-eight slabs of the width you suggest in one New York block), and a very uneven pavement would result—a worse condition than that of which you now complain. The more sensible way to proceed with curbing this evil is to plan carefully before the pavement is laid, as many cities now do, the substructures in the paved districts.

Rockland, Me. J. M. DANIEL.

The Newlands-Broussard Bill

SIR: In your Current News of April 18 you state that the Newlands-Broussard river-regulation and flood-prevention bill was adopted by the irrigation conference at Denver. You do not state, probably did not know, that this action was rescinded the next morning.

The matter was brought up when relatively few were present at the evening session of April 11, and whether true or not, many seemed to feel that the matter had been crowded through without knowledge of what they had been voting on. After they had begun to compare notes and find how few knew what were the details, and realize that the subject was not germane to the conference, and had been pushed in season and out of season by a professional advocate, the conference determined to back up when there was a fuller attendance. Governor Carey, of Wyoming, voiced the feelings of those present and in a powerful and dramatic speech asked that the advocates voluntarily withdraw the request, for while they did not care to indorse, neither did they care to oppose the bill. Some humor was added to the situation when it developed that not half a dozen outside of those from California who were supporting it had ever read the bill!

The motion was reconsidered and endorsement refused.

The resolutions as a whole recommended some modifications in the land laws, but more especially more sense in the regulations of the departments. The general feeling seemed to be that the laws themselves were in most cases sufficient and proper enough but that the regulations were onerous and oppressive, not carrying out the spirit of the laws. There was incidentally considerable rather harsh criticism both of the Reclamation and of the Forest Service, but as the hope was for some constructive measures, these matters were kept in the background.

The Governors' conference had been set for that week, and was probably the occasion for the request for conference by the Secretary of the Interior. The cause is the same as that which prompted the large attendance at the irrigation conference—a very keen feeling of dissatisfaction among the Western States at the policies of the Interior Department (land and reclamation especially) and of the Forest Service—and both meetings served to voice the feeling in the matter and were a step for united action.

I send this for your general information, for it is evident that you were misinformed regarding the action of the conference regarding the Newlands bill. The press-bureau which sent news of the preliminary action to you was probably not anxious to correct the report.

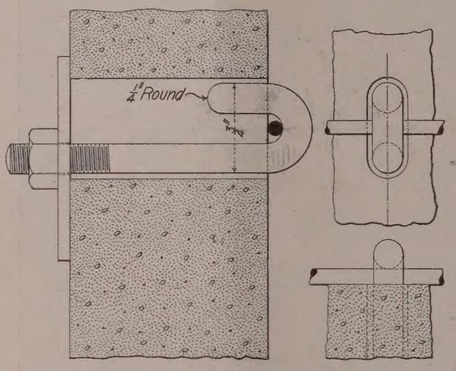
L. G. CARPENTER,
Denver. Consulting Engineer.

[The article referred to by Mr. Carpenter was prepared from a U. S. Government report which evidently was sent out before the second action was taken. A complete report of the resolutions adopted was printed, however, in the Current News of the issue of April 25.—EDITOR.]

Concrete-Steel Fence Posts

SIR: I have read with a great deal of interest the article in the Engineering Record of Feb. 14, page 186, on the concrete fence posts along the line of the New York Catskill Aqueduct by William M. Stieve and beg to suggest to Mr. Stieve and others interested in such posts a very simple and effective way to fasten the fence wires. The method is used by me in fastening wires to T-iron posts.

Holes are made in the post when cast for as many wires as are to be used. These holes take screw-bolt hooks of ¼-in. iron of the shape shown in the accompanying drawing, but the hole, instead of being round, is oblong and long enough to allow the width a, which is ¾ in., to enter the hole. When the nut is screwed up the hook draws the wire into the hole, thus securing it to the post. This means that every post takes an equal share of strain and prevents the wire from slipping.



Wire Clamp for Fence Post

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Special Solution of a Certain Type of Quadratic Equation

SIR: In none of the available books for engineers has the writer found the following treatment of a certain type of quadratic equation for which there exists a ready numerical method of solution. As is well known, the standard solution by completion of the square for the equation in the form $Ax^2 + Bx + C = 0$ is

$$x = (-B \pm \sqrt{B^2 - 4AC})/2A$$

The form in mind in this treatment is of another kind, and must necessarily have numerical coefficients in the problems to which this simplified solution applies. The algebraic form and the theory of the solution are as follows:

$$(x + a)(x + b) = c \qquad (1)$$

On carrying out the operation in the first member this becomes

$$x^2 + (a + b)x + ab = c \qquad (2)$$

Transposing the term ab and adding to both sides the quantity $(a + b)^2/4$ and finally simplifying and taking the square root of both members of the equation, there results

$$x + \frac{a + b}{2} = \pm\sqrt{c + \left(\frac{a - b}{2}\right)^2}$$

The rule for the solution therefore bebecomes: Add the square of one-half the algebraic difference of a and b to c on the righthand member of the equation; extract the square root with the double sign and call this value $\pm m$. Take also n equal to one-half the algebraic sum of a and b and add this to x. Then

$$x + n = \pm m$$

or

$$x = \pm m - n$$

There are several cases which commonly occur. The numerical examples given below will serve to indicate how economical of time and effort the brief solution presented proves to be.

Case 1.—Suppose

$$(x + 40)(x + 60) = 70$$

Then one-half the difference of a and b is 10,

$$x + 50 = \sqrt{70 + 10^2} = \pm 13.038$$

and

$$x = -36.962 \text{ or } -63.038$$

Since both of these results are negative a problem yielding the roots given would not be common in practical work.

Case 2.—If

$$(x + 40)(x - 60) = 70$$

then

$$x - 10 = \sqrt{70 + 50^2} = \pm 50.695$$

and

$$x = +60.695 \text{ or } -40.695$$

Case 3.—Both a and b may be negative. This case, a common one, is typified by the equation

$$(x - 40)(x - 60) = 70$$

Then

$$x - 50 = \sqrt{70 + 10^2} = \pm 13.038$$

and

$$x = +63.038 \text{ or } +36.962$$

Case 4.—Still another form of common occurrence is of this type:

$$(60 - x)(40 - x) = 70$$

In this case

$$50 - x = \sqrt{70 + 10^2} = \pm 13.038$$

and

$$x = +63.038 \text{ or } +36.962$$

these results being identical with those in the preceding example.

It will be noted that the solution requires merely an inspection of the form in which the numerical quantities appear in the original equation. It will also be noted that the operations are upon the numbers alone. The quantity added to c is squared; hence it is not necessary to take account of the sign of the half difference, once it is correctly obtained. The solution is based fundamentally upon the method of equating coefficients and a similar rule might perhaps be found for a cubic equation of a form like equation (1).

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